The Image at the End of the World

Communities of practice redefining technology on a damaged Earth

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Abstract

(Inter)governmental efforts to deal with the climate crisis are all based on a definition of technology that makes the consolidation of two incompatible aims—economic growth *and* environmental sustainability—seem possible. Technology is supposed to make the decoupling of economic growth from environmental depletion a reality. Technology has become a magic word granting us a way out of the climate crisis without changing anything fundamental. This specific definition of the word is invested with a strong—and well financed—drive to keep existing power structures in place. However, the paradox at the heart of this reading of technology has not gone unnoticed. The definition of the word technology in the climate crisis has become brittle; the mismatch with lived experience and material practices makes the word 'uninhabitable'; giving rise to many new terms associated with communities of practice which give voice and shape to different definitions and roles for technology on a damaged Earth: permacomputing, computing within limits, collapse informatics, salvage computing, slow tech, redundant technology, low-tech, feminist technology, convivial computing, disability driven development and more.

Building on *Keywords: A Vocabulary of Culture and Society* by Raymond Williams (1976), I describe practices giving expression to different definitions of a single keyword, technology, by quite literally seizing control over the means of communication as the means of production. These communities of practice are not only taking control over the elements of network technology within their reach, they are also actively shaping the vocabulary used to discuss this. This dissertation aims to bring understanding of how the language around these infrastructures expresses this change, bringing the means of production in line with the interests of practitioners. Each practice, when situated historically, can teach us something about their transformative character and potential, which together constitute a low theory about questions emerging from these projects, fostering experimental togetherness, a pragmatic learning of what works and how (Graeber, 2004; Stengers, 2005). Exploring the contested meaning of technology—a word which holds a pivotal position in debates about ways to tackle climate change—can provide important insight into how this position emerged and support the experimental performing of other worlds that demonstrate computing otherwise is possible and doesn't only consist of dreams, but also tests ideas in code, hardware and community organisation.

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Introduction

I'd like to take you to a rooftop, half a century ago. It's 1966. On that roof sits a 28 year old man, high on 100 micrograms of LSD. Wrapped in a blanket against the February chill, he gazes at the horizon, waiting for his trip to kick in. He was just high enough to see the slight curvature of the earth in the distance. It made him think of something Buckminster Fuller said in a lecture a few weeks earlier, about how people's misbehaviour towards the planet was rooted in the way they perceived the earth, from their perspective, as flat and infinite. At that moment, Stuart Brand became convinced that if we ever saw an image of the earth from space—whole, tiny and adrift—it would change people's perspective on everything (Obst, 1977).

Entrepreneurial as ever, his hope for more sustainable ways of living drove him to order several hundreds of buttons and posters with the text "Why haven't we seen a photograph of the whole Earth yet?" and began selling them at the Sather Gate of the University of California in Berkeley (Turner, 2006, p. 69). Influencer avant-la-lettre, this was how he framed his merch sales: as a campaign to convince NASA to take and share a photo of the whole planet. Most likely oblivious of his lobby, which was targeting students, NASA took a full colour photo in November 1967 (NASA, 1967, see figure 1).[1] Brand used it on the cover of the first *Whole Earth Catalog*, a quarterly magazine he started, sharing reviews of tools and books with the goal of empowering people to build communities that would change the world. Technology played a central role. "Access to tools" was supposed to translate to unlimited possibilities, captured in the words on the first page: "We are as gods and might as well get good at it." (Brand, 1968, p. 1)

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[1] Brand's campaign was all about 'bragging rights', alluding he successfully pressured NASA to release a 'dangerous' photograph that would shake people to their core, making them change the way they live. Hinting NASA would not take and share such a photo because of the threat it posed to 'the man', was bold considering this was not the first photograph of the whole earth from space. In December 1966 a full-disk black and white photo was taken by the ATS-1 satellite. In September 1967 the DODGE satellite took a filtered colour photo which was published November 10 1967 and was titled "First Color Portrait of an Angry Earth" (Dempsey, 2019).

The *Whole Earth Catalog* wasn't about the change in perspective Brand promised, it wasn't about communicating the fragility of Earth's ecosystems. The magazine took the form of a sales catalogue, featuring products, tools and books, helping readers determine "[...] what is worth getting and where and how to do the getting" (Brand, 1968, p. 1). This emphasis on access to tools marked a radical shift in the way technology was perceived in countercultural spheres. In the early 1960s the Free Speech movement saw computers as part of the bureaucratic and nuclear power wielding military-industrial complex that threatened to destroy the world in the midst of the cold war. Yet a mere decade (and some reframing at the hands of Stewart Brand and others) later, the personal computer symbolised the exact opposite; it symbolised the potential for an egalitarian, self-organising society of free individuals who, by acting in their own self-interest, would change the world, from the bottom-up (Turner, 2006). Brand became the spin doctor bringing countercultural cachet to the computing industry, helping establish a progressive aura for an industry that would become an increasingly powerful threat to labour, privacy and the environment with very little regulatory oversight.[2]

Brand's *Whole Earth Catalog* and subsequent work and publications contributed to constructing a narrative about technology, influenced by countercultural as well as cybernetic ideas about information, technology and how to save the world, that consolidated existing power structures. The image that would change the world marked the beginning of the so-called computer revolution rather than the social and environmental revolution envisioned by many in response to the first wave of books published in the 1960s and 1970s, which warned of industrial capitalism's damage to the Earth.[3] At that moment

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[2] The most extreme instance of Brand bringing high technology together with countercultural preference for ecological and 'rustic' living was his promotion of physicist Gerard O'Neill's space colonies in Coevolution Quarterly, the successor to the Whole Earth Catalog (Davis, 1970/1975, see figure 2). Every inhabitant would have 5 acres of land and because there would be no natives, this frontier involves "no conquering, no exploitation, no guilt this time" (Brand, 1975, p. 5). His speculation that inside a space colony one could climb mountains where at the top you would be so weightless you could fly is not unlike Elon Musk's more recent promotion of Mars colonies: "It will be like, really fun to go, you'll have a great time" (Brand, 1975; Musk in Stockton, 2016).

[3] There were many publications warning of environmental damage published during those two decades. The most influential were *Silent Spring* by Rachel Carson, from 1962 and *The Limits to Growth* by Donatella Meadows, Dennis Meadows, William Behrens and Jørgen Randers, from 1972 (Carson, 1962; Meadows *et al.*, 1972).

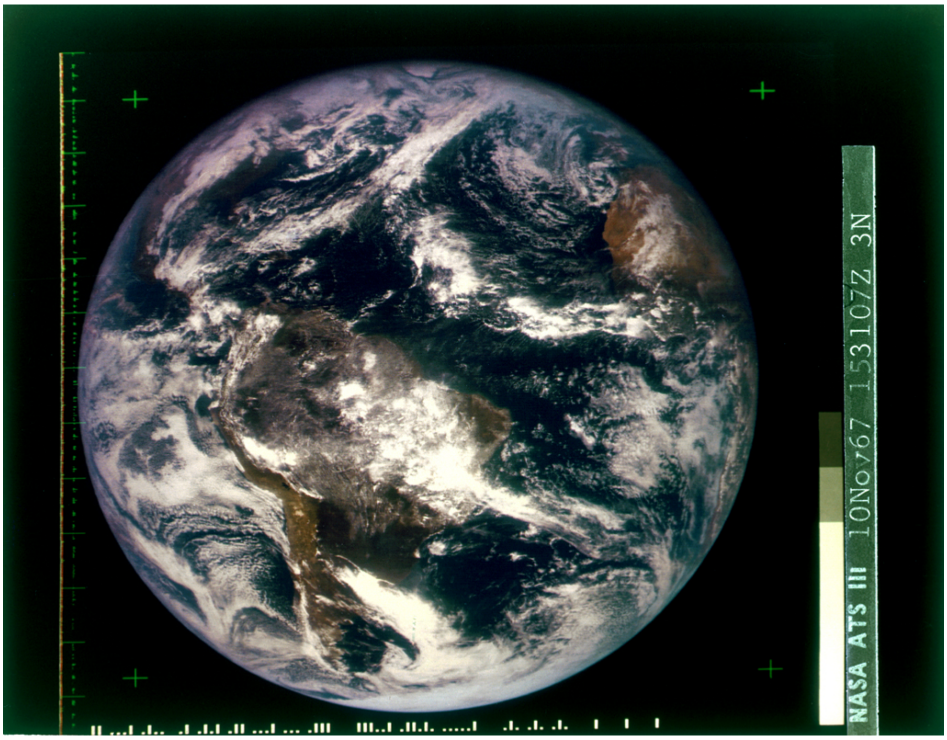
NASA ATS III 10Nov67 153107Z 3N

Figure 1: NASA (1967) *First color photograph of the whole Earth (western Hemisphere)* [Photograph]. Taken on 10 November 1967. Public domain.

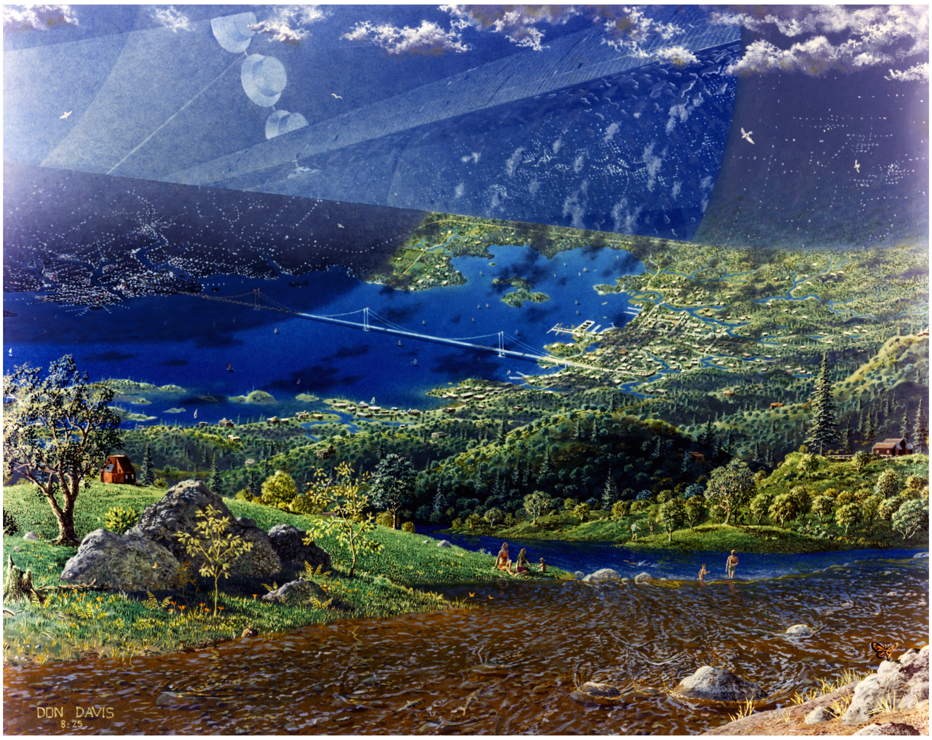
DON DAVIS
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Figure 2: Davis, D. (1970) *Endcap view with suspension bridge', Island Three cylindrical space habitat* [Painting]. Painted under the direction of space colonisation populariser Gerard O'Neill. Public domain.

two opposing and conflicting world-views collided, one based on limited and the other on unlimited natural resources, one arguing for degrowth, the other for growth. The image Brand chose as emblem of his tool-enabled movement expresses the world-view that bets on human ingenuity to allow for growth without damage. It expresses a way of seeing in a disembodied, distant and universalising way, the whole earth as laboratory experiment. This image also marks the start of this thesis of seeming contradictions, engaging with the complex systemic problem of climate change, while looking at small scale interventions. The title of this dissertation is a modification of Anna Lowenhaupt Tsing's (2015) *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins*. In particular her discussion of scale and scalability strengthened my resolve at the start of this project, to pay attention to small and often non-scalable interventions and practices (Tsing, 2015, pp. 37–43). Scalability banishes diversity, and it is in diversity that change might start.

Problem statement

The core problem this dissertation engages with is the environmental impact of Information and Communication Technology (ICT), and does so in two ways, direct and indirect, materially and on the level of discourse. First there is the direct material, environmental damage caused by the tech industry through the mining for raw materials, production, use and wasting of its products. The mining for raw materials such as rare earth elements (REE) and cobalt comes at a high cost, in terms of labour conditions and environmental pollution (Scheele, de Haan and Kiezebrink, 2016; Gwenzi *et al.*, 2018; Krummel and Siegfried, 2021). The production of microchips represents an immense use of electricity and water and releases harmful toxins affecting human health and the environment (Kim, Kim and Paek, 2014; Gupta *et al.*, 2021; Tanaka, Maples-Reynolds and Fowler, 2022). The energy use of ICT represents somewhere between 4% to 8% of global electricity consumption and is rapidly growing due to the rise of AI (Aebischer and Hilty, 2015; Belkhir and Elmeligi, 2018; Marks *et al.*, 2021; Crawford, 2024). The resulting e-waste represents a growing stream of non-recyclable, toxic debris. Only a very small amount of this material can be recovered, the rest is incinerated or shipped to countries with limited regulatory oversight, where it is disassembled in ways that are harmful to both the environment and the workers in the informal waste and recovery sector (Gabrys, 2013; Abalansa *et al.*, 2021). The damage being done is well established, as are the ways harm can be diminished. These efforts are hindered by a blind spot within sustainability studies, where ICT is often thought to bring larger gains in sustainability in other sectors, than the harm it causes itself (Kuntsman and Rattle, 2019). Research into what can be learned from small communities that *do* engage with this problem is lacking, and this is where this research project hopes to contribute insight.

This brings me to the second way I will engage with the environmental impact of ICT: at the level of discourse around the role of technology within climate crisis. It holds a unique position in debates about the best ways to tackle climate change and environmental collapse. It is through innovations in technology that (inter)governmental organisations and governments imagine staving off disaster while still aiming for economic growth. The concept of green growth, the theory that sustainable economic growth is possible by decoupling it from resource use and environmental harm, underpins green or eco-capitalist policies such as emissions trading and the trinity green consumerism, green technology and green taxes (Spash, 2011; Böhm, Misoczky and Moog, 2012; Fox, 2023). It also lies at the core of the UN Sustainable Development Goals (SDG), which are based on a Western economic, rather than an ecological, rationality (Banerjee, 2003; Salleh, 2019; van Norren, 2020). It also underpins the different interpretations of the US and EU Green New Deals (Ossewaarde and Ossewaarde-Lowtoo, 2020; Mastini, Kallis and Hickel, 2021).[4] Technology however cannot and does not diminish resource use, evidence points to the opposite (Parrique *et al.*, 2019; Santarius, Pohl and Lange, 2020; Freire-González, Padilla Rosa and Raymond, 2024). It is not enough to diminish the environmental harm caused by the ICT industry, as it will not decouple economic growth from environmental harm. It is therefore important to research shifts in the narrative about technology's role in the climate crisis. This is the second way my research engages with the damage caused by ICT. I will look to the extent small communities are changing the narrative, through redefinitions of technology in the climate crisis. I aim to share insight into these shifts in definition to support this much needed change in perspective.

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[4] Both the EU and US Green New Deal (GND) are important non-partisan efforts to support the energy transition in a socially just way. However urgent, they are the result of many compromises between often opposing viewpoints and still aim at economic growth. For a detailed discussion of the GND, see the work of economist Ann Pettifor and journalist and activist Naomi Klein (Pettifor, 2019; Klein, 2019).

Theoretical framework and research question

The (inter)governmental efforts to deal with the climate crisis are all based on a definition of technology that makes the consolidation of two incompatible aims possible: economic growth and environmental sustainability (Parrique *et al.*, 2019; Hickel and Kallis, 2020; Fox, 2023). This specific definition of the word technology is invested with a strong and well-financed drive to keep existing power structures in place. However, the paradox at the heart of it is not going unnoticed, which brings me to the central thesis of this project.

The common definition of technology in the climate crisis has become brittle; the mismatch between lived experience and material practices is becoming increasingly strong and visible. These cracks in the hegemonic definition of technology are giving rise to many new terms associated with communities of practice which give voice and shape to different definitions and roles for technology on a damaged Earth. Permacomputing, computing within limits, collapse informatics, salvage computing, slow tech, redundant technology, low-tech, feminist technology, convivial computing, disability driven development, and more. This large number of new terms can be seen as a symptom of this redefinition, as the prevalent understanding of the term becomes incompatible with the reality of certain communities of practice. These communities rethink ICT by diminishing its ecological impact and bringing it into alignment with their political aims, ranging from degrowth and environmentalism to decoloniality and trans*feminism. They create and hold space for different and diverse views on technology, challenging techno-utopianism, demonstrating workable alternatives to mainstream tech monopolies.

The format and theoretical framework of this project is an inquiry into a vocabulary, inspired by the Marxist theory of language developed by cultural theorist Raymond Williams. His cultural materialism, combined with philology, constituted a method to explore language as a site of struggle, with shifts in meaning providing insight into cultural transformation. His work *Keywords* features words that are key to understanding our society and demonstrates how these words take on new meanings over time, reflecting political, historical shifts (Williams, 1976). He selected a diversity of keywords, both abstract and concrete, such as nature, underprivileged, industry, bureaucracy, liberal and violence. He traced their etymology and historical development in order to ground them in the political and cultural context of the UK in the mid 20th century. Williams establishes words as important sites of political struggle and their meanings as

> "shaping and reshaping, in real circumstances and from profoundly different and important points of view: a vocabulary to use, to find our own ways in, to change as we find it necessary to change it, as we go on making our own languages and history." (Williams, 1976, p. xxxvi).

Even though my approach is not philological (I will not dive deeply into the etymology of terms such as the ones mentioned above, neither am I exploring a vocabulary related to a field as broad as culture and society), I will build upon his work by using one word—technology—and show how it splinters into a diversity of divergent words that reshape the relationship between it and culture and society, finding ways to do technology otherwise.[5] I will take these terms as entry points to describe different practices, placing them into a historical perspective and bringing them into relation with each other.[6]

The main research question is: how have several new terms for environmentally less damaging ICT, and their related practices, given expression to redefinitions of technology in relation to an escalating environmental crisis? To answer this, I will explore the historical terms *soft technology* and *Appropriate Technology*, the contemporary term *permacomputing*, six terms associated with feminist server practices—*ecofeminist and always unfinished space making*, *i diakomistis*, *jenga computing*, *patchwork computing*, *seismography of artistic practices* and *with / in limits*—and photographic practices giving a visual redefinition of technology. I will discuss these through an exploration of four sub-questions: What is the etymology of each of the terms? What are the key concepts? How does each compare to past practices? And lastly, how does each challenge prevailing definitions of technology? These questions help contextualise each practice while also allowing me to draw parallels and make comparisons and explore what they can learn from each other, and what they can teach us.

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[5] As my use of the term 'otherwise' suggests, this is a feminist project. The word otherwise is a keyword itself, indicating an "ethico-onto-political commitment to the insistence of the possible against the pull of the probable" (Meek and Fontanilla, 2022).

[6] I'm picking up where Williams left off. He deemed his inquiry open for amendments, corrections and additions, hoping it would continue to spark active and ongoing discussions, a shaping and reshaping from different points of view, a vocabulary in action. Some pages were left blank for this purpose (Williams, 1976, p. XXXVii). This dissertation can be seen as an addition to the very short entry for the word 'technology' in *Keywords*.

Objective and keywords-as-method

The objective of this inquiry is to demonstrate that this wealth of new terms is a symptom of technology's hegemonic definition, naturalising class interests, is becoming brittle, creating space for alternative interpretations, with the motivation to foster this transformative potential. The relevance of studying the shifts in the meaning of a word over time, is that these reflect political shifts and are symptoms of underlying social contradictions. They say something about how 'consensus reality' emerged, where it starts to break down and these insights help imagine how change might be brought about (Fritsch, O'Connor and Thompson, 2016). Williams' work insists on the impossibility of one definition, because in periods of social change, these definitions become brittle and the 'correct' use of words becomes impossible. The work he did is about multiplicity: meanings, not meaning. One of the central aims of *Keywords* is to show that some important social and historical processes occur *within* language (Williams, 1976, p. XXXiii). Language doesn't simply reflect change, new ways of seeing the relationship between words and concepts appear in language as new words, adaptations, extensions or a narrowing of existing definitions. New and old meanings exist side by side and "can become alternatives in which problems of contemporary belief and affiliation are contested." (Williams, 1976, p. XXXiii)

Keywords is the practical exploration of his cultural materialist account of language and constitutes a valuable method of socio-cultural analysis, especially in relation to transformative practices (Crowley, 2018; Moran, 2021). To Williams, language is a *productive* social practice: "a practical material activity; it is indeed, literally, a means of production" (Williams, 1977, p. 38; Moran, 2021). [7] In *Keywords* he takes very familiar, ideologically loaded words and analyses their material and historical context to reveal that their 'common sense' interpretation often works to naturalise or promote class interests (Moran, 2021). Because he positions people in a dialectical relation with language, both producing it and being produced by it, there is the possibility of resistance and contestation

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[7] Williams builds on the work of Marx, and the 1929 work *Marxism and the Philosophy of Language* by Vološinov (Crowley, 2018).

(Crowley, 2018). *Keywords* is not a glossary and the relations Williams draws between words are not reductive. They are there to show the varied and variable interrelations of a vocabulary in practice. Exploring the contested meaning of technology, a deeply familiar word holding such a pivotal position in debates about ways to tackle climate change, can provide important insight into how this position emerged and support imagining how to change the *Whole Earth Catalog*'s (Brand, 1968, p. 1) "[w]e are as gods and might as well get good at it" into this dissertation's battle cry: we are as humans and might as well get used to it.

The outcome of this research demonstrates how this developing vocabulary around less damaging tech is put into practise by developers, artists and hackers working with ICT. Here, Williams provides more inspiration, this time not in terms of methodology, but in relation to the reason why it matters to pay attention to these small scale practises. He noted, in a text first published in 1978, that the means of communication are the means of production, intrinsic to forms of labour and social organisation (Williams, 2005). Unsurprisingly for a Marxist, he argues for the means of communication to be in the hands of the immediate producers, so they can be transformed into a means that the producers collectively control, shape and use, released from their function as commodity and from their part of power structures (Williams, 2005). In *Keywords for Radicals: The contested vocabulary of late-capitalist struggle*, which also builds on and expands Williams' work, sociologist Kelly Fritch, writer Clare O'Connor and social theorist AK Thompson (2016) argue that seizing control over these means of production requires us to first understand them, because this is the basis of envisioning how we can then bring them closer to our own interests.[8]

A low theory as gift

In this dissertation, I describe practices that are quite literally seizing control over the means of communication as the means of production. Not only are they taking control over the elements of network technology within their reach, the communities of practice involved are also actively shaping the vocabulary used to discuss it.[9] This dissertation hopes to generate understanding of how the language around these infrastructures gives expression to practices that shape and envision change, bringing the means of production in line with the interests of practitioners. Each practice, when situated historically, can teach us something about their transformative character and potential, a low theory about questions emerging from these projects, fostering experimental togetherness, a pragmatic learning of what works and how (Graeber, 2004; Stengers, 2005). My motivation is close to how anthropologist David Graeber expressed what the role of an anarchist anthropology could be:

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[8] The work *Keywords for Radicals* has helped me formulate my objective and method more clearly. The work picks up where Williams left off and invited different authors to explore words which started to loose their common sense meaning in radical discussions, that is, political discussions seeking fundamental societal change. With this work, the authors responded to their observation that speech had become untransparent (Fritsch, O'Connor and Thompson, 2016).

> "to look at those who are creating viable alternatives, try to figure out what might be the larger implications of what they are (already) doing, and then offer those ideas back, not as prescriptions, but as contributions, possibilities—as gifts." (Graeber, 2004, p. 8)

My use of the term *low theory* is borrowed from Graeber, who defines it as theory dealing with those "real, immediate questions" that transformative projects deal with in everyday practice (Graeber, 2004, p. 9). This is very closely related to another use of the term, by gender and queer theorist Jack Halberstam (2011, p. 15), who builds upon cultural theorist Stuart Hall's idea that theory is not the goal but "a detour en route to something else" (Hall, 1991). Hall in turn build upon Marxist philosopher Antonio Gramsci's work. The meandering legacy of the term expresses an important part of its meaning, low theory as ongoing process, rooted in activist practice, a theory orienting "toward problem-solving knowledge or social visions of radical justice." (Halberstam, 2011, p. 17). Even though philosopher of science Isabelle Stengers uses the term 'minor key' rather than low theory, I believe her concept of 'ecology of practices' as social technology is equally related. Her insistence on taking practices seriously and fostering an experimental togetherness among them so they can experiment changes and "unfold their own force" has informed my commitment to describing the potential of practices, rather than defending them as if they were weak, to foster what works and how (Stengers, 2005, p. 195).

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[9] There is only limited access to network infrastructure. The cables are owned by large corporations such as TATA communications, Microsoft or Colt; and Internet exchange points are either owned by groups of ISP's or by non-profit associations. Data centres are owned by corporations. Only at the level of (rented) servers and the software that runs on them can the communities I describe take direct action. Other forms of agency and activism can only happen on the level of lobbying policy makers, via protests and interventions in the public debate. This story is situated at the edge of this larger network infrastructure, which is explored in depth in chapter 1.

A carrier bag theory of technology

> "A leaf a gourd a shell a net a bag a sling a sack a bottle a pot a box a container. A holder. A recipient. The first cultural device was probably a recipient..."
> (Le Guin, 2019, p. 29)

Rather than exploring one practice in depth, or narrowing in on one best practice, framework or model, I chose a pluriversal as well as feminist approach, constituting a carrier bag theory of technology, inspired by author Ursula K. Le Guin's essay *A Carrier Bag Theory of Fiction* (2019).[10] In her essay, she redefines technology as cultural carrier bag, rather than weapon of domination, and describes how before the tool forcing energy outwards, there was the tool that brought energy home. I take Le Guin's suggestion seriously, and will avoid the "linear, progressive, Time's-(killing)-arrow mode of the Techno-Heroic and redefine[s] technology and science as primarily cultural carrier bag rather than weapon of domination" (Le Guin, 2019, p. 36). By doing so, I can approach small scale technological practices as realistic counter-narratives to Big Tech. I can describe them alongside each other, without a hero progressing neatly from a to b, in competition with anything and anyone standing in his way, as a gathered bunch of useful things, "a bag holding things in a particular, powerful relation to one another and to us" (Le Guin, 2019, p. 34). My commitment to this method of collecting and gathering was strengthened further through reading about the concept of the pluriverse in the work of semiotician Walter Mignolo, anthropologist Arturo Escobar and the publication *Pluriverse: A Post-Development Dictionary* which, together with (eco)feminist theory more generally, informed my choice for the multiple and situated over the singular and universal (Mignolo, 2018; Escobar, 2018; Kothari *et al.*, 2019).

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[10] The essay was originally published in 1988. Le Guin based her theory on that of Elizabeth Fisher's *Woman's creation: sexual evolution and the shaping of society*, proposing a carrier bag theory of human evolution (Fisher, 1980).

Practice-led research: experimental publishing

This is a practice-led research project, meaning the research uses artistic practice as a means of exploring research questions with the aim to develop new insights and understandings through this process. My artistic practice has always combined research, writing and experimental publishing, and this project is a continuation of this.[11] The practice I used as a means of exploring my research questions was that of writing and publishing throughout the project, to establish a conversation with those concerned by the research. This approach was not only informed by Graeber's *Fragments of an Anarchist Anthropology*, it also resonates with media studies scholar Janneke Adema's work, which explores alternative models of scholarly communication, such as open access publishing, living books and experimental publishing, which challenge ideas of individual authorship and the fixed text (Graeber, 2004; Adema, 2021). In her work, Adema articulates how publishing itself, as well as the platforms on which we publish, play an integral role in shaping the research process (Adema, 2023). I chose to support this reciprocal relation with the communities I worked with by making interim outcomes of this research project public in a 'light' way, using methods of publication which required little energy to produce and minimal resources to circulate. Because knowledge production is always collective—and I was generously given time and energy by the people I interviewed and spoke with throughout the project—I wanted to give as much of the gathered insights back. My practice took the form of workshops, writing papers and essays and performing; I created a wiki called the *Damaged Earth Catalog* and at some point found myself knee-deep in the long and winding history of tarot decks.[12]

It was important to conduct this publishing in and from the middle of the project, acknowledging that as a researcher I am part of what I research, therefore, my findings are multi-layered, partial, politically situated as part of a moral collective. The findings are also robust, because they are the result of a collective process of knowledge production. Throughout I have drawn upon Stengers' (2017, p. 81) *Another Science is Possible:*

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[11] With experimental publishing I mean more than publishing outside conventional formats; I define it in a similar spirit as the Experimental Publishing master course at Piet Zwart Institute, where I work as graduate research supervisor—as a critical participation in the technical frameworks and socio-political processes through which things are made public and how these can support creating publics, collective thinking and action (Experimental Publishing, 2018).

[12] All publications, workshops and talks are listed in the appendix. A selection of publications is included in the portfolio, including a short contextualising introduction to each.

A Manifesto for Slow Science: relations are the main aim, not citation rankings or high profile journals. Speed demands an insensitivity to things that slow us down, such as friction, negotiation and relating to others. Slowing down means "reweaving the bounds of interdependency [...] creating relations and knowledges worth cultivating." (Stengers, 2017, p. 82). Publishing is not unidirectional, it's a conversation which allows questions to be formulated that matter primarily to those who have a stake in the research(ed), and secondly to the researcher. Stengers argues for collective apprenticeships and the art of creating 'suspense', meaning that instead of concluding with a 'and therefore' or a 'and thus we must', to conclude with a successfully established relation without knowing what that may lead to. Stengers situates her manifesto within the larger scheme of resisting the coming barbarism, asking why we are unable to act when faced with the climate crisis, and doesn't give any 'prescription' or concrete method and instead insists on each reclaiming operation to be particular and partial, because they are always situated, starting where we have been separated from our power to think, feel, imagine and act. Her work will be a continuing reference within this thesis and her manifesto has informed this research project's commitment to creating suspense and publishing as creating relations and questions that matter to those concerned.

Collaborative and embedded research

This approach was equally informed by the context of this project, a collaboration between the Centre for the Study of the Networked Image (CSNI) and The Photographers' Gallery (TPG). CSNI is a research group part of the School of Arts and Creative Industries at London South Bank University, gathering a group of researchers from cultural studies, software studies, contemporary art, media and performance practice collectively building knowledge about how network culture transforms the production and circulation of images. The group uses the term networked image to centre this effort around an understanding of the image as computational object which circulates through social as well as infrastructural networks, including the politics of infrastructure and its environmental impact (CSNI, 2020). CSNI approaches publishing as an experimental field of practice and research object in itself, as something much more than a means of dissemination of research, a generative context for this project. CSNI facilitates transdisciplinary, collaborative and embedded research with the cultural sector (CSNI, 2020). This project was embedded at the Digital Programme at TPG, another meaningful partner in this research.

TPG was the first independent gallery in Britain devoted to photography (The Photographers' Gallery, 2018). Its first exhibition 'The Concerned Photographer' (1971), curated by photographer Cornell Capa, perfectly expressed its mission to promote photography as an art form, as well as an instrument to raise societal debate. Capa wrote about the exhibition, which focused on reportage photography confronting issues ranging from child labour to the Civil Rights movement and gold mining:

> "The Concerned Photographer finds much in the present unacceptable which he tries to alter. Our goal is simply to let the world also know why it is unacceptable." (Capa in The Photographers' Gallery, 2018)

The photos in the exhibition had circulated through mass media before ending up on the gallery wall. They were socially motivated and needed to circulate widely in order to impact their viewers (The Art Institute of Chicago, 2006). This concern for photography as a medium to instigate debate and conversation resulted among other things in the launch of the Digital Programme in 2012.

The launch of the Digital Programme was motivated by the need of TPG to rethink (or unthink) photography, as it was confronted with both theoretical and practical problems posed by digital technology, resulting in dramatic shifts in the digital image as it became increasingly screen-based and networked (Sluis, 2012).[13] The Digital Programme, led by Katrina Sluis until 2019, aimed to reflect on and work with the technical, creative and cultural languages of photography produced by not only photographers but also computer engineers, web developers, networked communities, social scientists and other practitioners (Sluis, 2012). Again, the opening show was a perfect reflection of its mission. *Born in 1987: The Animated GIF*, curated by Sluis, featured a selection of animated GIFs created by a wide range of practitioners on invitation, and was later opened for contributions by the public. Sluis wanted to disrupt expectations about screens, mainly the fetishisation of resolution and image quality, and present a different economy of the image, one in which value is not based on uniqueness but on mass circulation (Sluis, 2012). This research project inherits many of the ambitions of that project, and was sparked by the question of how this mass circulation of the networked image, which is now more and more absorbed by the fetishisation of resolution, affects the environment, and aimed at conversation with photographers, developers, artists and activists about this question, for which CSNI and the Digital Programme at TPG were the perfect environment.

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[13] Part of the Digital Programme's activities is the online platform *Unthinking Photography*, which maps and responds to photography's role in contemporary culture through essays, commissions, interviews and IMGEXHAUST, a curated aggregate of content from around the web ('Unthinking Photography', 2017).

Coming back to my practice of experimental publishing, the main outcome, besides this dissertation and the publications I included in the portfolio, is the *Damaged Earth Catalog*, a living document, which is lightweight and evolving.[14] The *Catalog* features a growing collection of terms associated with environmentally less damaging ICT and links each to an entry describing its related practice. This carrier bag brings different communities of practice, from academic to grassroots, historical to contemporary, into relation and makes all visible to each other. One might argue this would create a splintering (or even tribalism), but the wiki aims to create strategic synergies and alliances that allow the parties involved to honour differences, while still collectively providing a larger scale resistance to the damaging social and economic practices of the tech industry. In line with its content, the wiki's implementation is minimal and lightweight, expressing a prefigurative politics along the lines of how David Graeber described anarchism (and prefigurative politics):

> "It's that [anarchism] is primarily concerned with forms of practice; it insists, before anything else, that one's means must be consonant with one's ends; one cannot create freedom through authoritarian means; in fact, as much as possible, one must oneself, in one's relations with one's friends and allies, embody the society one wishes to create." (Graeber, 2004, p. 7)

The *Damaged Earth Catalog* shares descriptions of terms belonging to communities of practice which create and rehearse less damaging roles for technology in the climate crisis.[15] Instead of envisioning tools as a vector for change, a growing number of people are working on small-scale social and technical methods and tools which aim to reduce the environmental impact of network technology itself, while bringing these tools into alignment with their politics. I started gathering these practices in the *Damaged Earth Catalog*. All consider technology as something that is material as well as political, but never as a substitute for politics. Together they form a powerful counter-narrative to that proposed by the tech industry: Appropriate Technology, convivial technology, liberatory technology, redundant technology, salvage computing, low-tech, feminist technology. These are but a few examples from a growing collection of terms and associated practices. Instead of the consumer activist approach of shopping for the right tools to bring about change, as proposed by the *Whole Earth Catalog*, its evil twin, the *Damaged Earth Catalog*, shares a diverse range of situated practices that reimagine the roles technologies could play on a depleted planet. A selection of entries are included in the portfolio, giving space to the practice of publishing from the middle that has guided and informed this research.

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[14] The wiki as living document is another affinity between the *Damaged Earth Catalog* and *Keywords*, which can be seen in many ways as a type of hypertext, each word linking to others, allowing a reader to discover the work jumping from link to link, rather than in alphabetical order. The wiki offers the reader a way to navigate the texts in different ways, creating connections between entries (Williams, 1976).

[15] Communities of practice, discussed in detail in chapter 3, are "[...] groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly."

Low theory as open pedagogy

This project is practice-led, collaborative and embedded. It gathers a collection of terms in a carrier bag theory of technology. I'd like to complement the description of my project with a brief discussion of the methods used for data collection within each chapter. For this I will return to Halberstam's interpretation of low theory as 'open' pedagogy, detached from prescriptive methods and fixed logics (Halberstam, 2011). My multifaceted approach combines different methods depending on what the aims and context of the chapter is, and how I could relate to it as a researcher, clearly situating myself in relation to the research at the start of each chapter. In chapter 1 and 2 I use critical discourse analysis based on published historical material, creating a confrontation between hegemonic and counter-hegemonic conceptions of technology within the climate crisis. I review and analyse texts that give insight into how the 'common sense' role of tech came about, drawing on Halberstam, who draws on Hall who drew on Gramsci (Halberstam, 2011). In chapter 3 I take the role of a participant observer in a community of practice, basing my analysis on published texts by that community as well as on

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(Wenger and Trayner, 2015, p. 2)

observations as a participant. Chapter 4 uses semi-structured interviews that are then synthesised into descriptions of the practices of each community I engaged with. Each description has been read and approved by the interviewees.[16]

In both chapter 3 and 4 I draw on insights from feminist STS scholar Susan Leigh Star, especially their approach to the ethnographic study of infrastructure as infinite regress of relationships (drawing on anthropologist Gregory Bateson) (Bowker *et al.*, 2015: p.476). Her relational approach to the study of ICT informed my transdisciplinary approach, combining the study of how communities think about their infrastructure with occasional analysis of technical artefacts when needed (Star, 1999).[17] My method of observation and interviewing was further informed by the work of sociologist Christine Hine in *Ethnography for the Internet: Embedded, Embodied and Everyday.* Hine points to the strengths of small scale, in depth ethnographic research of the Internet offering an experiential approach which documents activities while keeping an open-mind about what a phenomenon might mean (Hine, 2015, p. 182). Hine suggests field notes based on observations and blog or social media posts for data gathering, and interviews for exploring specific issues in depth, allowing participants to respond to the researcher's tentative portrayals (Hine, 2015, p. 184). Lastly, chapter 5 combines critical discourse analysis with observations from the position of a co-organiser of an event. All chapters are grounded in a commitment to trans*feminist situated and accountable knowledge building (Haraway, 1988).

Contribution to knowledge and limits of the project

As briefly outlined at the start of the introduction, there is plenty of research available analysing the problem of environmental damage caused by ICT, in the engineering related fields of Sustainable Human-Computer Interaction (SHCI), ICT for Sustainability (ICT4S), as well as in the context of Computer Science, such as research fostered by the annual *Computing Within Limits* workshop (Nardi *et al.*, 2018). Social research on the environmental impact of technology and media is done in the fields of (Digital) Environmental Media Studies, Environmental Science and Technology Studies and Critical Data Center Studies (Frickel and Arancibia, 2021; Brodie *et al.*, 2023; Edwards, Cooper and Hogan, 2024). There is also a substantial body of research proposing approaches to addressing it in these same fields, from propositions for frugal computing to relational carbon footprinting and urgent calls for communal world-building (Vanderbauwhede, 2023; Pasek, Vaughan and Starosielski, 2023; Hogan and Blue, 2024). However, research that maps and describes a diversity of communities which experiment with small-scale social and technical methods and tools and which aim to lower environmental impact of ICT is lacking. If these practices are described at all, such as for instance those around feminist servers, it isn't done in the context of environmental concerns. The study of the practices of these communities provides valuable redefinitions of technology, reimagining and experimentally reshaping its role within the climate crisis, providing a contribution to these fields, but most importantly to those this research directly concerns: the communities themselves.

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[16] This community peer review process is inspired by CLEAR lab's community peer review process as described in *Pollution is Colonialism* by Max Liboiron (2021, pp. 138–145).

[17] Star's work has been very valuable to me, especially at the start of this project. Although her work only appears in chapter 4, it has inspired the approach to infrastructure as "frozen discourses that form avenues between social worlds and into arenas and larger structures" (Clarke and Star, 2008, p. 115).

I have focused the selection of communities of practice on the EU and US, giving a Western perspective on the subject matter, yet the research project has a decolonial and ecofeminist aim. The reason for this choice is that the cause of the problem this study deals with lies in the Global North, and this is where the change of perspective on technology required to do something about it needs to take place.[18] Although practices from the Global South are not the topic of study, decolonial and intersectional (eco)feminist aims are woven into this project's methods and goal. Another limit I had to work with was that because I chose to discuss a diversity of historical and contemporary practices, my scope was large. This broad view, dealing with a range of different practices and bringing them into relation with each other, means the research cannot go into great detail in its descriptions of each community of practice. The aim is to give insight into how each is redefining technology through their practice, and I do so by highlighting certain elements of that practice. Neither the selection nor the descriptions are exhaustive and the dissertation deals with this limitation of scope by moving from very broad strokes in chapter 1, to increasingly detailed descriptions throughout the chapters, culminating in a discussion of its tiniest element: the small image.

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[18] I will use the terms Global North and Global South throughout the dissertation, fully aware of the gross oversimplification this divide represents but simultaneously wishing to steer clear of the older terms 'developed' versus 'developing' and 'first' versus 'third' world that imply hierarchy and contain a value judgement.

Structure of the argument

In Chapter 1 I discuss why it matters to pay attention to small scale practices redefining technology's role in the climate crisis, by looking into the role of technology as the 'fix' to keeping existing power structures in place because it allows for a so-called 'decoupling' of economic growth and environmental degradation. I discuss the response of the tech industry to criticism and the heavily burdened position individuals and communities find themselves in when trying to respond. I build upon the concept of capitalist sorcery and capture to understand the lack of public scrutiny required to challenge the position of tech at the level of governance (Pignarre and Stengers, 2010). Communities of practice are breaking the spells of capitalist sorcery through experimentation, an important venue of resistance, leading to a proliferation of new terms redefining tech's role in the climate crisis.

In Chapter 2 I discuss what earlier attempts at redefining technology looked like, to be able to later assess their influence on the present. This chapter looks back to the 60s and 70s to find out what attempts to change tech's role in climate crisis were made, by taking a closer look at two approaches: soft technology and Appropriate Technology. The counterculture and the start of the environmental movement resulted in experimentation with different forms of activism and social organisation, in which technology played a key role. One was abandoned as soon as the oil crisis was over, while the other, which proposed tech as the solution to environmental collapse, became the dominant ideology, fuelling the myth of 'green growth'.

In Chapter 3 I interrogate how permacomputing redefines technology in relation to the climate crisis. Permacomputing is a new term used by a small community trying to diminish tech's negative environmental impact. I discuss the origin of the term and look into its main characteristics through a discussion of two projects, *Uxn* and *What Remains*. I review how permacomputing inherited elements from past practices, and how it reasserts technology as part of the problem, a rematerialisation rather than dematerialisation. It starts to make space for issues of race, gender and class and the creative repurposing of discarded tech gives communities choice and agency, while challenging one of capitalist sorcery's most powerful spells: progress through technological innovation.

In Chapter 4 I discuss what we can we learn from (eco)feminist servers about redefining technology in relation to the climate crisis. This chapter pushes back at the male dominated space of tech and for lack of new vocabulary, coins 6 new words to hold space for important and relevant practices that are often so everyday and low key, nobody thought to name them. I look into why practices around feminist servers do not get associated with sustainability and what we can learn from doing so anyway. The ecofeminist emphasis on the connections between LGBTQIA+, environmental, decolonial, disability justice and feminist struggles helps to articulate what feminist servers have to say about different definitions of tech within climate crisis.

In Chapter 5 I return to the start of this dissertation, to the image that would change the world, and look at photographic practices engaging with the environmental impact of digital photography. The chapter aims to break capitalist sorcery's most powerful spells through the lens of the small image, a visual redefinition of technology (Pignarre and Stengers, 2010). The magic words efficiency and scale are interrogated and the potency of the small image as counter-magic, a politics embodied in the digital image, is tested through a discussion of the *Small File Photo Festival*, an event I organised with the team of the Digital Programme at The Photographers' Gallery.

This inquiry into a vocabulary in practice aims to demonstrate that this wealth of new terms, which contest the hegemonic definition of technology, is a symptom of a definition of technology no longer reflecting lived experience and material practices. The goal of this dissertation is to foster this transformative potential through the study of the shifts in the meaning of this word over time, reflecting political shifts and social contradictions. Looking into these words reveals something about how 'consensus reality' emerged, and where it starts to break down. These insights help imagine how change might be brought about.

Chapter 1

The Contested Meaning of Technology

I'll approach this chapter from the only perspective available to me at the start of this research, a person behind a laptop during the lockdown period of the COVID-19 pandemic, witnessing a rapid embrace of Software as a Service products in the hands of Big Tech, dictating how people organise themselves, educate, learn, care for and communicate with each other. My own practice as an artist, teacher and researcher working on Free/Libre Open Source Software (FLOSS) projects using non-proprietary tools to create and communicate, has made me aware of a rich tapestry of alternatives to these rented services. My work as part of artist collective GOTO10, as a teacher at the masters Experimental Publishing at Piet Zwart Institute, and my ongoing exchange with a network of people, collectives and organisations active in the field of art, activism and FLOSS have been a continuous inspiration to rethink digital infrastructures.[1] *At the edge of the network, people are dreaming of technology at the service of people rather than shareholders, and are redefining technology, resulting in an explosion of different words that give expression to this difference. This chapter starts by zooming out, sketching the terrain on which the repositioning and redefining of technology, by different communities described in subsequent chapters, takes place.*

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[1] I have been learning about technology otherwise with my comrades from GOTO10 between 2003 and 2011, my partner and collaborator Aymeric Mansoux from 2003 until today, my colleagues at Experimental Publishing between 2015 and today, and my friends at Varia in Rotterdam, esc medien kunst labor in Graz, Servus in Linz, Constant in Brussels, Technology in the Public Interest (TITiPI) and many others (see acknowledgements).

It explores the historical shifts in the definition of technology, at the level of international discourse around the climate crisis, from the 1970s until today, and why it matters to pay attention to practices that confront its contradictions and increasing brittleness.[2]

Introduction

In this chapter I'll discuss shifts in the meaning of technology by looking into the historical development of the role of technology in the climate crisis, the response of Big Tech to criticism about its own negative impact and the difficult position individuals and communities find themselves in when navigating this terrain. I'm using the word technology rather than ICT because I'm describing a history that starts at a time when ICT wasn't yet a dominant industry, and ends at a time when ICT is such a dominant industry that there is hardly any technology that doesn't involve some form of ICT. This chapter starts with the word technology as used in the discourse around the climate crisis, meaning the so-called 'high' technology involved in industrial automation, energy infrastructure and mass communication, as used mostly in an abstract fashion in public debate. It ends with a focus on ICT as offered by Big Tech in the context of my study: Alphabet, Amazon, Apple, Microsoft and Meta. Because I focus on communities from the Global North, I haven't included corporations such as Baidu, Alibaba, Tencent, and Xiaomi.

In the first section I'll recount the short history of technology's role in the climate crisis. Even though scientific consensus about the reality of the climate crisis exists since the 1970s and solidified further during the 1980s, the corporate entanglement with the international response to it defused its potential impact. I'll discuss how technology allowed for a narrative pivot, which transformed economic growth from being the source of environmental decline, to it being the solution: economic growth, enabled by technology, would be decoupled from environmental depletion.[3] A second narrative twist reframed technology from part of the problem of overproduction to solution through CO_2 emission control.[4] Both pivots allowed existing industries to stay mostly unchanged, and are mutually reinforcing: growth is necessary to generate the wealth needed to create the technological innovations to save humanity from climate disaster.

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[2] I start each chapter with a paragraph indicating my own position in relation to the topic, situating and introducing myself and my relation to the researched. This gives an idea of how the knowledge represented in the chapter came about and to whom I am accountable. This method is informed by Max Liboiron (2021) and their work *Pollution is Colonialism*.

[3] Here technology mostly refers to technology that makes industrial production processes more efficient, which was supposed to allow the production of more goods using less resources.

In the second part I'll look into how the IT industry responded to growing criticism about its own negative environmental impact. The tech industry handled demands for sustainability by focusing strongly on CO_2 emissions and avoided criticism by outsourcing its responsibility to companies and consumers on the edge of the Internet. I'll discuss Google as a case study to evaluate how serious the desire for sustainability is at the corporate level. I'll review the history of the tech industry's sustainability strategies—green computing, green IT & sustainable ICT, as response to sustainability demands from 1990 to now—to give insight into whether Google's case is representative of the sector in general. The strategy of continuing business as usual while individualising responsibility for a systemic problem has a historical predecessor in the plastic packaging industry. Individuals now find themselves responsible for 'littering' once again, this time in the shape of a CO_2 footprint.

In the third section I'll interrogate venues of resistance against an industry that plays such a pivotal role in the discourse on the fight against environmental collapse. I'll build upon the ideas proposed in Stengers and Pignarre's *Capitalist Sorcery*, with special attention to the concept of capture and infernal alternatives, as a way to understand the lack of public pressure required to challenge the position of the tech industry at the level of governance. It is not only a capture of the imagination, it is a concrete capture as most people in the Global North have become dependent on tech platforms, and find it hard to leave because of vendor lock-in.[5] The lords of platform have wedged themselves in between people and their work and kin. Breaking the spell of capitalist sorcery through experimental practice is an important venue of resistance that is leading to a proliferation of new terms that redefine tech's role in the climate crisis.

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[4] In this case technology refers to existing technology that produces renewable energy such as solar cells, wind turbines and hydrogen fuel cells or hypothetical technology that would allow (emission-free and large scale) capture of CO_2.

[5] Vendor lock-in occurs when users have become dependent on a service or product and cannot switch without substantial personal or financial costs. Tech platforms lock users in through several mechanisms, for instance through market domination or monopoly on a certain service where leaving means isolation, or through the use of proprietary standards for digital artefacts, where leaving means losing the ability to exchange in a particular file format, or a combination of both.

Technology and the climate crisis

The first theory about climate change stems from 1896, 127 years later the 28th United Nations Climate Change Conference (COP) took place in Dubai, with Sultan Al Jaber, CEO of Abu Dhabi National Oil Company (ADNOC) as president. How did the climate crisis become an international concern and why are oil executives leading efforts to manage it? Historian of science Spencer Weart (2011) points to Svante Arrhenius as the first Western scientist to write about global warming. In 1896 he predicted temperature rises due to the CO_2 emitted by the burning of vast amounts of coal. He saw it as a positive change, it would result in more agreeable temperatures and the CO_2 would improve crop yields. Weart points to the 1950s as a turning point. Two scientists, Roger Revelle and Gilbert Plass separately found CO_2 was building up in the atmosphere and warned this could have a warming effect, with problematic consequences in the future. In 1956 Revelle predicted Antarctic icecaps would melt and coastlines would flood. In 1965 the US President's Science Advisory Committee reported that by the year 2000 there might be measurable changes that could be disastrous for human beings. The crisis became a matter of growing concern from the 1960s onwards.

In the eighties climate science solidified and attempts at an international response were initiated, growing from hesitant call for more research to a desperate plea for immediate action to limit already ongoing damage to biodiversity, food supply, infrastructures and human health. The first IPCC report, issued in 1990, somehow remained hesitant and concluded the world had been warming but stated there was no conclusive evidence that this was caused by the greenhouse effect. The 1995 IPCC report did describe a discernible human influence on global climate. The 2001 report was more blunt and stated the world was rapidly warming, most likely due to an increase of greenhouse gases. The 2007 report said serious harm was already done in certain parts of the world and that the costs of reducing emissions would be far smaller than those of eventual damage. The 2023 report states "Some future changes are unavoidable and/or irreversible but can be limited by deep, rapid, and sustained global greenhouse gas emissions reduction" (IPCC, 2023, p. 18). Weart (2011) concludes that the realms of scientific research and public policy had never been more entangled, yet even so, research has had very little impact (Muller, Witt and Hasenheit, 2021, see figure 1.1).

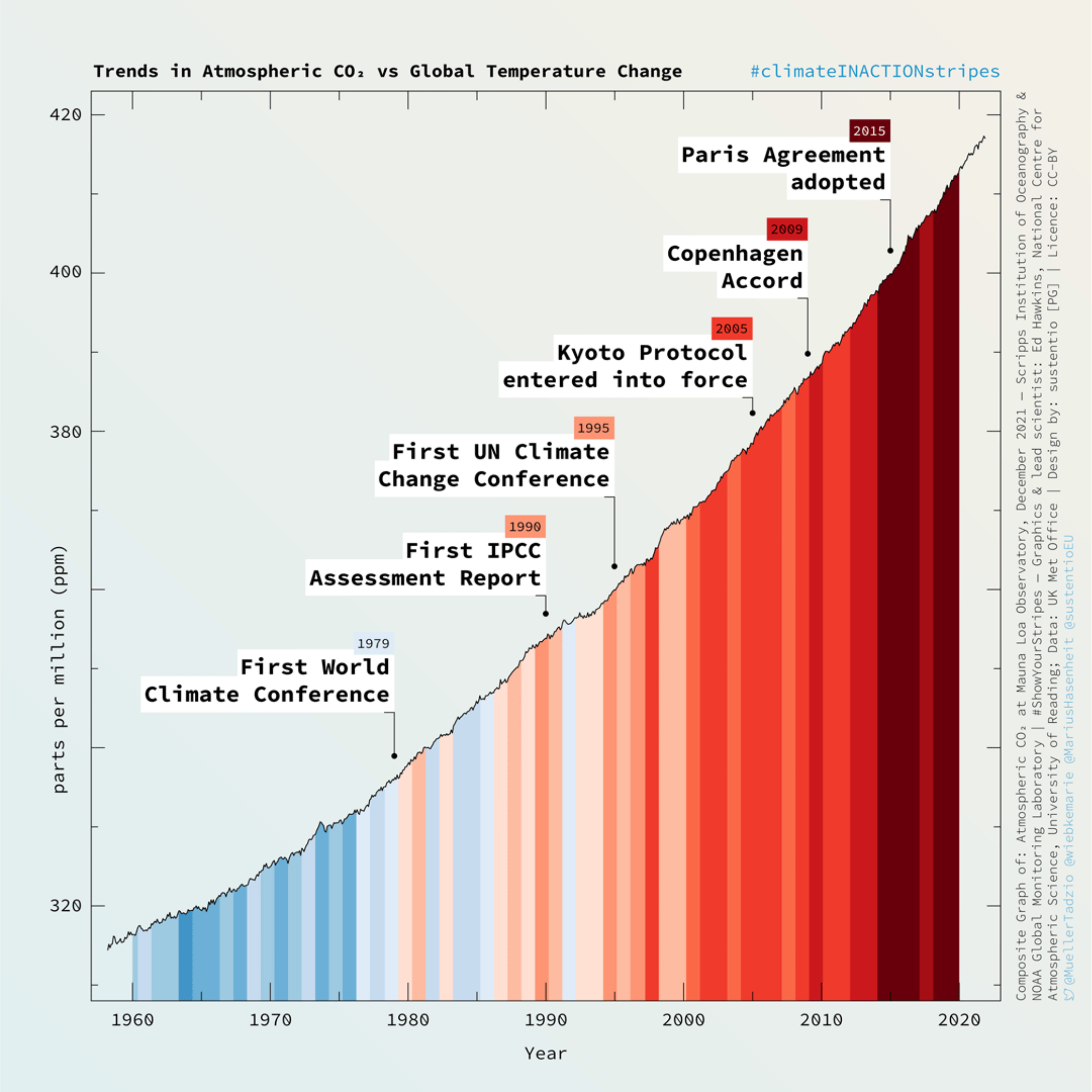

Figure 1.1: Muller, T., Witt, W. and Hasenheit, M. (2021) *Trends in atmospheric CO2 vs. global temperature change, 1958-2020, with climate conference dates indicated.* [Image]. CC-BY.

Even though firm scientific consensus about anthropogenic causes of climate change existed since the 1980s, the corporate entanglement with the international response to the climate crisis limited its potential impact. The international awareness of a global environmental crisis, which arose in the 60s, came about at the same time as several international institutions promoting approaches to 'earth governance' based on what sociologist Ariel Salleh calls 'life-dissociated ways of knowing' and measures emphasising voluntary corporate responsibility (Salleh, 2015, 2019). Technology plays a pivotal role in the strategies of these institutions. The following analysis of the entanglement between international public policy and corporate agendas is highly indebted to Salleh's research.

Poverty is the worst polluter

Since the invention and use of the atomic bomb in the 1940s the knowledge that humanity posed a threat to its own survival became mainstream. In the 60s and 70s, several scientific and popular texts on overpopulation, depletion of natural resources and the effects of pollution were published, most well known of which were *Silent Spring* and *The Limits to Growth*, leading to a growing global concern about the environment (Carson, 1962; Meadows *et al.*, 1972). In 1967 Sverker Ästrom and Borje Billner, Sweden's UN Representatives, proposed the organisation of the first United Nations Conference on the Human Environment (UNCHE). It was the first international attempt at tackling the global environmental crisis. The conference's secretary-general was Maurice Strong who, strangely enough, was an oil industry entrepreneur who made his fortune in the Alberta oil patch.[6] He persuaded India's prime minister Indira Gandhi to deliver the opening speech. Her speech reflected the tone of international environmental policy of the following decades by stating poverty was the worst source of pollution (Masood, 2015).[7] UNCHE took place in 1972 and led to the Stockholm Declaration listing 26, largely rhetorical, principles stating man has the right to a living environment that permits living with dignity and well-being and that the natural environment needs to be safeguarded for present and future generations. The declaration and conference didn't result in concrete measures but put environmental policy on the agenda of international diplomacy (Grieger, 2012).

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[6] In 2009 'oil man' Strong described his diplomatic approach as: "never to confront, but to co-opt, never to bully but to equivocate, and never to yield" (Masood, 2015)

[7] In reality low income countries were responsible for only 0.2% of global CO_2 emissions, against 42.5% for high income countries (Ritchie and Roser, 2023; Andrew and Peters, 2024).

One of the outcomes of the Stockholm Convention was the United Nations Environment Programme (UNEP), founded that same year by Strong. UNEP's goals were to develop solutions to a range of problems, including climate change. In 1988 the World Meteorological Organisation (WMO) and the UNEP founded the Intergovernmental Panel on Climate Change (IPCC), an intergovernmental UN body for the advancement of knowledge on anthropogenic climate change. The IPCC doesn't conduct its own research but prepares comprehensive reviews of scientific knowledge on climate change, including its social and economic impact. The reports formulate recommendations and potential response strategies and are key inputs into international climate change negotiations. The IPCC works in cycles of six to seven years and to date has published 6 assessment reports since 1988. The first report was published in 1990, the sixth report the 20th of March 2023.

In 1992 the United Nations Conference on Environment and Development (UNCED), also known as the Rio Earth Summit, was held. It resulted, largely because of the first IPCC report, in the United Nation Framework Convention on Climate Change (UNFCCC) being signed by 154 states. Maurice Strong, the oil industry executive who headed the UNCHE and UNEP, was secretary-general of the Earth Summit. The UNFCCC's decision making body, the Conference of the Parties (COP), gathers every year to assess its progress. The Kyoto Protocol, which was active from 2005 until 2020, was the first signed set of measures taken. Its successor, the Paris Agreement, took effect in 2016, was ratified by 196 countries, and is still active today. How did this corporate involvement evolve and influence international policy making?

Phase 1: the panic and the pivot

This corporate entanglement started when books such as the 1972 *Limits to Growth* appeared and wealthy industrialised countries started to be seen as the cause of environmental degradation (Meadows *et al.*, 1972). Economist Erik Gómez-Baggethun states that *Limits to Growth* popularised the belief that a "redistribution of wealth was the favoured option to harmonise environmental protection and social justice." (Gómez-Baggethun, 2019, p. 71) This caused quite a panic and during the eighties, Gómez-Baggethun argues, under the banner of sustainable development, growth was suddenly reframed as solution to, rather than cause of, environmental collapse. These ideas found their way into a 1987 UN report entitled *Our Common Future*, also known as the Brundtland Report. The report promoted the view that growth would be sustainable through resource-efficient technologies and economic activities using less material, a process of so-called 'dematerialisation'. Growth's pivot from problem to solution, institutionalised through the Brundtland report,[8] laid the groundwork for a happy marriage between neoliberal globalisation, free trade and deregulation, made palatable through the narrative of 'sustainable development' with its technology-enabled dematerialisation.[9]

In 1991 the Business Council for Sustainable Development (BCSD) was founded, by the Swiss entrepreneur Stephan Schmidheiny, who was charged by Maurice Strong, again, the Secretary-General of the UNCED and Oil Industry executive, with the mission to inject the voice of business into the Rio Earth Summit of 1992 (WBCSD, 2023). The plan succeeded, with the BCSD largely designing the Summit's eventual measures, all emphasising voluntary corporate responsibility (Salleh, 2015).[10] In 1995 the World Business Council for Sustainable Development (WBCSD) was founded as a merger between the BCSD and the World Industry Council for the Environment, another trade association created by the International Chamber of Commerce (ICC) and headed by the managing director of British Petroleum, after the Rio Earth Summit (WBCSD, 2023). According to a 2011 Greenpeace report on the measures carbon intensive industries have taken to block climate legislation, the WBCSD is one of the key players in delaying effective international measures to fight climate disaster. It's executive committee was dominated by the world's largest carbon intensive corporations until 2011. The report shows how the WBCSD institutionalised a direct private sector input into the UNFCCC agenda and thereby secured voluntary corporate responsibility (Adam *et al.*, 2011).[11]

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[8] The Brundtland report was written by the Brundtland commission with Maurice Strong as one of its members.

[9] Today, the ideas behind Sustainable Development are revitalised by the Sustainable Development Goals of the UN, which are active from 2015 until 2030. Dematerialisation with growth in GDP only appears in countries that have outsourced their industry to developing nations (Gómez-Baggethun, 2019).

[10] One of the outcomes of BCSD's efforts to influence Rio Earth Summit was the book *Changing Course: A Global Business Perspective on Development and the Environment* written by Schmidheiny (1992). It introduces the concept of 'eco-efficiency', producing more goods using less resources. The book repeats the idea that poverty is the greatest polluter.

This influence further materialised in the 2012 Rio+20 'green economy' agenda, which conceptualises nature and living beings as 'natural capital' and 'economic assets', and economic growth as a necessary step towards sustainability. The idea is that nature gets a price tag and is included in business calculations as 'natural capital'. [12] This was meant to trigger its protection through free market mechanisms. This allowed a focus on the alleviation of poverty rather than on the causes of poverty and environmental degradation, which would have meant addressing the accumulation-driven economies of the Global North (Kothari *et al.*, 2019). The 'green economy', just like its predecessor 'sustainable development', relies on so-called dematerialisation, also called 'decoupling'.[13] Decoupling is the de-linking of economic growth from environmental impacts through technological innovation that would allow more to be done while using less resources, an increase in efficiency. This decoupling hasn't materialised anywhere except in high-income nations that outsourced their industry to low-income countries; a displacement of environmental and social cost from the Global North to the Global South (Hickel and Kallis, 2020; Jackson, 2017 in Gómez-Baggethun, 2019). The idea that technology, and specifically IT, would 'dematerialise' certain polluting sectors gained popularity in the 90s and even though it has been debunked, the narrative still lingers today (Lange, Pohl and Santarius, 2020; Freitag *et al.*, 2021).

The decoupling myth and IT are closely linked. As Ariel Salleh describes in *Earth System Governance*, decoupling relies heavily on information systems monitoring and managing natural and social systems. However, it doesn't account for two mutually reinforcing phenomena. First of all, an 'imperial mode of living' in the Global North, where every 1 kilo of consumed goods requires 5 kilo of resources to be displaced from elsewhere, a process known as extractivism (Brand and Wissen, 2012; Salleh, 2019).[14] Secondly, a multiplication of environmental damage done by the computerisation of every aspect of everyday life (Salleh, 2019). Salleh argues that Earth System Governance (ESG), a political agenda linked to the Anthropocene argument, promotes a governance model based on an opaque network of private and public actors "dispersing accountability while questioning the role of the state" (Salleh, 2015, p. 433). Her materialist analysis of ESG points to the close ties between the Tech Industry, neoliberal governance—making extensive use of quantification and modelling—and globalisation.[15] How has the decoupling myth—allowing the pivot from growth as problem to solution, heavily relying on colonial power relations and environmental damage—affected local, national and international attempts to combat global warming?

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[11] COP28 took place in the United Arab Emirates, with Sultan Al Jaber, head of the Abu Dhabi National Oil Company as President-designate. COP29 took place in petrostate Azerbaijan. It's chief executive, Elnur Soltanov, Azerbaijan's deputy energy minister, was filmed agreeing to facilitate fossil fuel deals at the climate summit (Horton, 2024).

[12] The writers of *Another Future Is Possible!* protested against the 'green economy' proposals of the UN Rio+20 summit, which according to them, would only benefit corporations and transnational banks. The document states: "With such an apparently innocuous term like 'green economy,' they are expecting to submit the vital cycles of nature to the rules of the market and the dominance of technology" (Social Forum, 2012). They pointed out how the green economy agenda would not only continue environmental destruction, but also expropriate indigenous people from their territories.

[13] Decoupling is basically the next iteration of Schmidheiny and the WBCSD's concept of eco-efficiency, coined in 1992.

Phase 2: (growth) + (CO_2 reducing technology) = sustainability

After a century of climate research, there is an overwhelming scientific consensus about current global warming being disastrous and anthropogenic. Denial is an increasingly untenable position. There is even consensus about there being consensus, an absurd necessity, as scientists continue to face a tiny, but very vocal, group of contrarian scientists who manufacture doubt and persuade policy makers, and public opinion, that uncertainty about the causes of global warming should lead to more research rather than expensive measures. This discourse justifies inaction and inadequate efforts (Oreskes and Conway, 2010; Cook *et al.*, 2016; Lamb *et al.*, 2020). Organised climate change denial has played a crucial role in blocking US domestic legislation and this in turn contributed to the US hindering international policy making (Dunlap and McCright, 2011). Today, as denial falters, the Tech Industry jumps in to market itself as part of the solution. It offers to dematerialise certain polluting sectors, while it simultaneously lobbies policy makers to block legislation that would make it mandatory to disclose and decrease its own negative environmental impacts.

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[14] The term extractivism originates from South-American activism and describes the socio-ecologically destructive practice of natural resource extraction for export. Chagnon et al. argue it is a practice based on subjugation, depletion, and non-reciprocal relations and is the opposite of environmental sustainability (Klein, 2014; Chagnon *et al.*, 2022).

[15] Earth System Governance is a field of research which was started in 2009 by Frank Biermann. It studies modes of governance that can steer actions to mitigate climate change. Its top-down methodology is based on systems theory and it assumes predictable systems, a linear connection between human activity and natural effect. It doesn't focus on, for instance, supply-chain transparency to hold corporations accountable for environmental harm caused by their products, but approaches the management of the natural environment by attempting to establish consensus on thresholds and boundaries within which the earth system can regenerate itself and economies can operate. This threshold theory of pollution is described as based on colonial land relations by Max Liboiron (2021).

Climate change denial has also always been about delaying regulatory measures that would hurt certain industries and positions of geopolitical power. Dunlap and McCright (2011, pp. 144–145) view such attempts at blocking legislation as part of a larger effort to defend the modern Western social order, a fossil fuel powered industrial capitalism. Political scientist Cara Daggett (2018), in *Petro-masculinity: Fossil Fuels and Authoritarian Desire*, describes how global warming threatens vast networks of privilege, and how fossil fuel use has solidified white patriarchal rule. Daggett juxtaposes petro-masculinity, which defended itself through denialism, to the equally masculine ecomodernism, with its push for economic growth as the requirement for the innovation and entrepreneurship needed to fix the climate crisis.[16] Proponents such as Elon Musk and Arnold Schwarzenegger solve the tension arising between environmentalist and modern industrial discourse by offering a seemingly symmetric merging of the two—a shift in politics that argues for economic growth as requirement for the development of new technologies to create a sustainable future. This narrative became dominant in the 90s (Hultman, 2013).

The Tech Industry is perfectly positioned in this shift from the denialism of petro-masculinity to tech-bro ecomodernism, which acknowledges the climate crisis but, rather than changing current modes of overproduction and extractivism, offers a tech fix that allows for business as usual and the vast networks of privilege described by Daggett to remain intact. The marriage between growth and environmentalism enabled by technology relies on a shift in focus from reducing production of goods to CO_2 emission control. This allows existing industries to stay in place mostly unchanged, even though the environmental damage is for the largest part done on the production side, outsourced to other (less ecomodern) countries. The automotive industry did not have to vanish in favour of public transport, because the Hydrogen Fuel Cell would turn Schwarzenegger's Hummer into a zero emission vehicle (Hultman, 2013). This is the second pivot in the narrative that has successfully delayed effective measures to combat climate change.

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[16] Ecomodernism is a type of modernist environmentalism which turns to technological development for environmental protection through economic decoupling. It rejects the idea of harmonisation with nature and instead aims to make more room for nature by intensifying human activity and separating human societies from nature. Any technological means to do so is fair game, from nuclear power and geo-engineering, to high-tech farming and genetic engineering. Stewart Brand (2009) was an early promoter of ecomodernist ideas through his book *Whole Earth Discipline: An Ecopragmatist Manifesto.*

The ecomodernist narrative of technology framed as solution rather than part of the problem of overproduction, and that of growth framed as solution rather than cause of environmental collapse are mutually reinforcing. Growth is necessary to generate the wealth needed to create the technological innovations to save humanity from climate disaster. Next to this decoupling, the Tech Industry plays a decisive role in the history of capitalism. It allows for the continuing extraction of surplus value through automation and labour control, something AI researcher Meredith Whittaker and human ecology researcher Andreas Malm both unpack in detail (Malm, 2016; Whittaker, 2023). Whittaker describes how the roots of modern computing are in efforts of worker control, through automation and disciplining labour, inspired by technologies of control developed on plantations (Whittaker, 2023). Malm has researched the same era, mid to late 19th century, describing the switch from water powered to coal powered mills. He comes to the same conclusion as Whittaker, as fossil fuels were at first not cheaper but gave British industrialists more control over their workers, allowing them to switch from decentralised and skilled labour to unskilled labour, which was centralised in large industrial zones. Workers became replaceable and lost their leverage to negotiate their wages and working conditions (Malm, 2016). This development is still ongoing, with several AI summers announcing another phase of automation disguised as smartness through anthropomorphism. Since the advent of AI research in the 1960s there have been several AI summers, periods when AI was perceived as very promising and it was easy to find funding for further research. Each time, promises of achieving general intelligence in machines were made, only to be abandoned a few years later. Even though general intelligence was unattainable, each AI summer did however deliver tools for further automation of very specific tasks usually performed by workers. From the 'analytical engine' automating the Jacquard loom, deskilling weavers, to the 'artificial intelligence' of ChatGPT and Midjourney, automating certain types of writing, helpdesk work, visual art and design, each development resulted in the deskilling of workers, turning them into easily replaceable ‘prompt artists’.[17]

The Tech Industry is situated at the centre of capitalist accumulation and holds the golden ticket to keeping current networks of privilege in place. The next wave of automation is currently in the making with the rolling out of the Internet of Things (IoT) and its ‘smart connectivity’ which employs robotics, Machine Learning (ML), Artificial Intelligence (AI) and edge computing.[18] This AI summer is so hot, Claus Schwab, founder of the World Economic Forum, called this development the fourth industrial revolution.[19] Despite this hype, there are rising concerns about surveillance, online political manipulation, racial and gender bias in automated decision making processes, monopoly power and consequent geopolitical influence. Next to this, the computerisation of every aspect of society and daily life comes with an enormous production of electronic devices and subsequent energy and resource use that even the casual observer can’t help but notice.[20] In the next section I’ll explore how the industry has responded to criticism and how one element of the fourth industrial revolution, edge computing, can be seen as a key aspect of the Tech industry’s tactic to offload responsibility while maintaining business as usual.

The response of the tech industry to criticism

What precisely is edge computing, and how did it become a CO_2 emission accounting trick that allowed Big Tech to avoid being held accountable for its impact on the climate crisis? I started this research project during the pandemic, when video conferencing provided an example of how platforms reduce network traffic and latency by offloading certain computational tasks to the client, or a node close to them. These client-side calculations are called ‘edge computing’ because the edge is the entry point to, or endpoint of, the network, depending on your perspective. On the edge are smart phones, laptops, PC’s and a rapidly growing mountain of IoT devices, such as coffeemakers, smart city surveillance equipment and self-driving cars. Video conferencing software makes use of edge computing for the calculation of the background image, or blur, some platforms allow users to set. While a user is streaming video and moving about in front of their camera, their computer is continuously calculating which pixels are background and which are foreground, in order to replace the background with an image of the user’s choosing. Performing these calculations in the cloud would be too slow, and the extra data transmitted would congest the network at the point where it has the smallest capacity: the last mile.[21]

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[17] AI summers are followed by AI winters, the periods when interest dwindles and funding sources dry up. It is outside of the scope of this dissertation to discuss this in detail. The paper *Capitalist Magic* gives insight into the rhetoric of the AI spring of 2014 – 2020 (see portfolio).

[18] Edge computing is a type of decentralised computing and data storage done closer to where it is needed to prevent delays and lag due to network bottlenecks. For instance, instead of streaming a video from ‘the cloud’, a data centre far away from a user, it can be streamed from a Content Delivery Network located close to a user.

[19] Whether it really merits the status of a separate stage in industrialisation or can be considered a revolution is debatable since it simply continues the process of automation through the use of IT that has been taking place since the 70s.

[20] The impact of AI on the environment is difficult to determine because industry is not sharing data about energy use. However, when even the industry itself starts sounding the alarm, there might be a problem. In January 2024, at Davos, Sam Altman, CEO of OpenAI, claimed the industry is heading for an energy crisis (Strubell, Ganesh and McCallum, 2019; Crawford, 2024). I explore the energy demands of hyperscale data centres in *A Tale of Two Data Centres* (see portfolio).

It is an industry trend to shift network bottlenecks into local computational tasks. This is not a new method, it started in the 1990s with the advent of Content Delivery Networks for a faster distribution of video to end users. Today data storage and computational tasks are both offloaded to, or close to, the edge node in order to improve latency and reduce network traffic. It is particularly helpful for tasks that require fast processing speed, such as video conference backgrounds, facial recognition and augmented reality, but also for bandwidth heavy applications such as cloud gaming and the growing pile of smart objects on the edge of networks, that are constantly phoning home to corporate servers, generating massive amounts of data to be processed; real-time data generated by sensors and users, with zero tolerance for latency.[22] After all these years of centralisation through Software as a Service and cloud computing, when software and data were moved from personal computers and small office servers onto centralised, corporate servers many network hops away, some of that is once again decentralised, but not without a tight, centralised grip on the top layer, which remains in the stronghold of the network’s core data centres.

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[21] The last mile is the part of telecommunication infrastructure connecting the end user to the network. Network infrastructure has a tree topology, with high capacity, long distance trunks connecting to lower capacity, short distance, branches, connecting to even lower capacity twigs. The last mile is often a speed bottleneck, its smaller bandwidth limiting the amount of data that can be transferred at a given time.

[22] An example would be the detection and identification of objects and their trajectory by autonomous vehicles.

This decentralisation is of a very particular kind and is connected to the rolling out of several interrelated new infrastructures which all have an environmental cost. Edge computing is often combined with Machine Learning (ML) because the massive amount of multimodal data (i.e., video and audio) that is constantly being sensed by IoT devices, needs the rapid processing that ML can provide (Zhou *et al.*, 2019, pp. 1742–1743). Not only is ML very resource intensive, it requires edge devices to be equipped with some form of AI accelerator. This has two consequences: an increase in electricity consumption and an explosion of newly produced devices, and consequently e-waste, because older end-node devices aren't compatible with services using ML. In certain IoT settings, edge computing means micro data centres are required in between end-nodes and data centres, to decrease latency for devices that are too resource constrained to perform heavy computation on large datasets themselves. These 'data centres in a box', similar to the previous example, mean another increase in electricity consumption and newly produced hardware. Instead of increased efficiency of existing computing infrastructure to reduce environmental impact, an infrastructural domino effect is taking place leading to a massive expansion.

Because edge computing also concerns mobile devices and machines, faster cellular networks are required. The rolling out of 5G cellular networks is a result of this. At the moment of writing, it is mostly marketed as mobile broadband for handheld devices, useful for watching videos or playing games while on the road. It offers the transfer speed needed for businesses making use of edge computing, without them needing to rethink their centralised core infrastructure. 5G is rolled out to accommodate the growing IoT, even though this is based on predictions rather than current needs. As mentioned earlier, the enormous amount of devices constantly communicating to servers require more bandwidth. An autonomous car for example, requires edge computing to decide to hit the brakes on time, and with the industry's plans to have an increasing number of them on the road, high bandwidth is needed for the communication of more latency tolerant data to the cloud. As more and more mobile devices come online, mobile bandwidth needs to keep up with this development. 5G is notoriously energy inefficient though. According to Earl McCune, professor in the Electronic Circuits and Architectures group at TU Delft, 2G had an energy efficiency of 60%, "For 5G, the efficiency will be only 10%, meaning that [for every 10 watts] nine watts will be turned into heat" (Engelsman, 2020).

Edge computing is part of the so-called fourth industrial revolution, with its expansion of several interrelated infrastructures. Edge detection in video conferencing, allowing different backgrounds to be set, is but a small example from the wider field of computer vision and image processing. It is however a relatable example of how edge computing often means non-optimised hardware does the heavy lifting, which is energy inefficient. When users notice their computers heating up and their fans making noise in an attempt to stay cool (and in the worst cases failing and shutting down), their phone and computer are performing computational tasks for Microsoft, Google, Zoom and others. Users are paying for the electricity and have to update their hardware if they want to continue to use the services offered. Next to people assuming the cost for this increase in electricity use and purchase of hardware, there is the massive environmental impact these increases bring. These developments are business as usual, reframed by Big Tech as part of an increase in sustainability, because they stabilise or lower energy consumption, and therefore CO_2 emissions, at the core of the network, in data centres. This shift of responsibility for climate impact distracts from the overall increase in energy use and hardware production required to roll out these services at the edge.

Promises versus practice

To assess the commitment of Big Tech to reduce their environmental impact, I'd like to briefly review the promises that are made. The overall argument against Google, Microsoft, Amazon and other cloud service providers being 'green' is of course that their business model is based on growth and stimulating consumption and thereby production, the main cause of our current ecological crisis. But even if we forget this argument for a moment, the practices powering the business model are worth having a closer look at. I will review Google's sustainability promises and practices to unpack in concrete terms what their sustainable promises are based on.[23] I will focus on Google because it claims to be "the cleanest cloud in the industry", so if there are plot holes in its sustainability narrative besides the gaping one of being in the advertising business, it doesn't bode well for those clouds of a lesser green (Stiver, 2020).[24]

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[23] I based this analysis on their 2020 sustainability report, in which Google still claims to be carbon neutral. They have abandoned this claim in the meantime, and their 2024 report aims at carbon neutrality by 2030. They claim to run on 64% carbon-free energy which also doesn't hold up to scrutiny as outlined in this section (Google, 2024).

Google's most pertinent claims are twofold: operating 100% on renewable energy and wanting to "disrupt the waste economy" by maximising product use and reuse (Google, 2019; Google, 2020a, p. 3). The renewable energy claim is truthful depending on how you define the scope of a company's operation. Besides, whether the way Google acquires its renewable energy is of benefit to society is also questionable. Google powers its data centres and offices with renewable energy, but stopped its own renewable energy R&D project *RE<C* in 2011 because "RE<C would not be able to deliver a technology that could compete economically with coal" (Koningstein and Fork, 2014). Only 4 years after its launch November 2007, Google researchers came to the conclusion that more disruptive energy innovations were needed in order to stop climate change, which would require more investments into R&D, but from others, not from Google. If a corporation with a 2020 revenue of 181.69 billion dollar cannot invest, who can?

Today Google places its data centres in the vicinity of, for instance, a wind farm and purchases its energy there. Close to where I am based, in Eemshaven, the Netherlands, Google constructed a hyperscale data centre and made a deal with a local energy provider to purchase all of the energy produced by a local wind farm. Microsoft did something similar when building a datacenter in Hollands Kroon, a mere bike ride from my home, purchasing all energy produced by a local wind farm for 10 years. According to the provider, Vattenvall, the energy could power 370,000 households. These wind farms have received subsidies by the Dutch government with the goal of achieving green energy and emission targets, but because they end up solely covering the energy demand of newly constructed data centres, representing additional instead of existing energy use, no progress is made and taxpayers are indirectly sponsoring Google's green public image.[25]

In the Netherlands energy providers cannot keep up with the demand for renewable energy by data centres. To accommodate the data centres, the Dutch government, together with energy providers and market parties, propose using the national climate agreement to change the legal framework to shorten the time to realise a new connection to the grid (Weerwind and Steembakkers, 2019, p. 23). The same is happening in other countries. In Ireland, another popular destination for the construction of new data centres, Eirgrid reports that by 2027, electricity demand from data centres will have risen to 31% of total national demand, with the expansion and development of Ireland's public transmission network being shaped by the intensive energy demands of data centres, aided by state legislation and planning (Bresnihan and Brodie, 2019). The energy demands of data centres is not only accepted as a given, rules are bent, laws are adjusted, just to accommodate them.

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[24] In the same Google cloud blogpost where Google declares itself to be the cleanest cloud in the industry, it is also announced that it will deploy a cloud region in Saudi Arabia, using a local strategic reseller sponsored by Aramco, a Saudi oil and natural gas company (Stiver, 2020).

[25] The story of how Google and Microsoft's hyperscale data centres arrived in the rural municipality of Hollands Kroon, under the pretence of sustainability, is told in the lecture-performance *A Tale of Two Data Centres* (see portfolio).

Not only do Google's sustainability claims rely on the gobbling up of subsidised renewable energy projects, the 100% carbon neutral claim only covers Google's data centres and offices. It doesn't cover the energy use caused by their products as soon as the data packets have left the Google owned data centre (Lin *et al.*, 2020). Google has built 21 hyperscale data centres around the globe, but in order to bring data closer to high traffic areas, it uses smaller 'edge Points of Presence' (PoP) data centres. For popular, high-bandwidth content such as video, the latency would still be too much, so even smaller data centres, the Google Global Cache, making use of third-party Content Delivery Networks (CDN), hosts content that is in high demand. PoP's and CDN's aren't owned by Google, they only host its equipment, and aren't covered by the carbon neutrality claim, which only concerns networking infrastructure under Google's direct operational control, as can be learned from an Ernst & Young accountants' review report from 2020 (Young LLP, 2020, p. 2). Google's sustainability report (Google, 2020a, p. 80) mentions only business travel and employee commuting are compensated in the GHG protocol scope 3 category of down- and upstream emissions. From the 12,529,953 tCO2e total 2019 emissions it is unclear what Google has included in the scope 3 'other' emissions, since these have not been independently reviewed. The main point is that even based on Google's own, unreviewed reporting, only 46% of total emissions were reduced and neutralised (Google, 2020a).

The previous assessment is based on Google's own reporting. Independent research has varying outcomes, none as optimistic as Google's 2020 carbon neutral claims. According to a 2016 study, a life-cycle assessment of YouTube's delivery and viewing, Google only compensates between 1% and 5% of total YouTube CO_2 emissions (Preist, Schien and Shabajee, 2019, p. 8). A more general study on ICT's energy use from 2017 estimated data centres to account for 45% of total ICT CO_2 emissions (Belkhir and Elmeligi, 2018, p. 457). The difference between the two studies can be explained by the fact that the latter also takes energy use in the production phase of a computer or server into account, which boosts the percentage of data centres, filled to the brim with regularly renewed hardware. The former however, includes emissions from the entire end-to-end delivery of a digital service, of which only the Google data centre is compensated with renewable energy. In either case, whether its 1% or 45%, independent reports conclude Google's services are nowhere close to being powered by 100% renewable energy.

The public's perception of Google as a green company is very important to its brand value. In a 2020 report by Alphabet for the Carbon Disclosure Project (CDP) the loss of this perception is mentioned as the second risk climate change indirectly poses to Google, potentially resulting in decreased revenues due to reduced demand for products and services.[26] Google deems this risk "about as likely as not" to materialise (Alphabet, 2020, p. 9). The third risk mentioned, is a change in customer behaviour due to changes in socio-economic conditions (Alphabet, 2020, p. 10). If climate change results in people living in more precarious conditions, they will buy less and advertisers will stop using their services. Google optimistically deems this risk "unlikely" to materialise. The report also includes opportunities that climate change might bring. One opportunity that Google deems "virtually certain" is that their investment in Google Earth and other products associated with sustainability, will result in increased brand loyalty and an associated increase in revenue. Another opportunity, rated "very likely" to materialise is Google's returns on investment in downstream low-emission technology (Alphabet, 2020, p. 16). The return on investment is confidential but Google hopes to profit while generating just enough energy to manufacture Google consumer products in the near future. Nowhere in the report is it mentioned that overconsumption, stimulated through advertisement, which makes up over 80% of Google's revenue, is one of the key drivers of environmental collapse (IPBES, 2020; Alphabet, 2021, p. 33). Google is itself a risk factor to climate change, but as long as it can maintain its green reputation, it can profit from its sustainable image and increased demand for renewable energy. Google is not a risk to its own bottom line, not until consumer capitalism crumbles under the pressures of climate disaster.

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[26] The Carbon Disclosure Project is a non-profit organisation providing a voluntary annual CO_2 emission reporting process to companies, cities and states, founded in 2000.

The second claim I'd like to briefly examine is Google's promise to "disrupt the waste economy" by maximising use and reuse of products (Google, 2019, p. 2). According to an anonymous source, this reuse consists mainly of metal server racks and cabinets. The convenient switch from percentages to units in their overview of waste diversion from their 2020 Environmental Report supports this suggestion (Google, 2019, p. 75). The 'landfill diversion rate' from the same report concerns "waste diverted to a more sustainable pathway than landfill or incineration without energy recovery" (Google, 2020a, p. 75), meaning in 2020 90% of data centre waste could still have been incinerated, albeit with energy recovery. That same year, only 19% of components used for machine upgrades were refurbished inventory and while the report mentions 9.9 million components having been resold into the secondary market that year, there is no mention of a percentage, so I can only guess that my anonymous source could very well be right. Last but not least, Google uses custom hardware for all their servers and consumer products, meaning it cannot be reused by third parties. An example is their edge TPU, a custom build integrated circuit to run accelerated ML at the edge. Their statement about needing to disrupt the waste economy is only a promise at best.

To conclude, even the greenest cloud in the industry is not that green, and is mostly concerned with a sustainable appearance as competitive edge, not with becoming a truly sustainable business. Changing appearances while maintaining the existing polluting and damaging practices is the hallmark of greenwashing. The 2020 Greenpeace report *Oil in the Cloud: How Tech Companies are Helping Big Oil Profit from Climate Destruction* captures this nicely by outlining how Google, Microsoft and Amazon all have connections to some of the world's dirtiest oil companies for the explicit purpose of getting more oil and gas out of the ground and onto the market faster and cheaper (Donaghy, Henderson and Jardim, 2020). All three companies are aware of how this looks and have updated their websites saying they target the energy, rather than oil and gas sector. In

May 2020 Google announced it will no longer take on new contracts but will continue to work with existing ones: Chevron, Total, Schlumberger and Cognite + Aker BP. Amazon and Microsoft have made no such promises and while announcing optimistic carbon neutral, or even carbon negative goals, continue to make it easier for oil companies to find and produce oil.

Reframing business as usual as sustainability

To evaluate if Google's reframing of business as usual as sustainability is a sector-wide problem, I will look into the history of the tech industry's sustainability strategies from 1992 until the present. Green ICT is the practice of environmentally sustainable computing. It is a broad and rather vague term that includes any practice reducing the impact of ICT in the production-, use- and end of life phase, as well as reducing the use of hazardous materials, the repairability and recyclability or biodegradability of e-waste. It also encompasses the use of ICT to make other sectors more sustainable. Engineering scientists Lennerfors, Fors and van Rooijen distinguish three historical phases in the development of Green ICT discourse: Green Computing, Green IT and Sustainable ICT (Lennerfors, Fors and van Rooijen, 2015, p. 765). The first phase, Green Computing, started the same year as the UN earth summit in Rio de Janeiro, in 1992, with the voluntary *Energy Star* labelling programme of the US Environmental Protection Agency. This phase focused on the sustainability of the ICT devices themselves, such as reducing the energy use of CRT monitors.

The second phase, Green IT, kicked off in 2007 when the Gartner Institute released a white paper stating ICT used 2% of the UK's total energy consumption, about as much as the aviation industry (Mingay, 2007). A year earlier, former US vice president Al Gore published his influential book *An Inconvenient Truth* (Gore, 2006). Next to that, the Kyoto Protocol, ratified by 192 parties in 1997, had set greenhouse gas emission goals with a commitment period starting in 2008. All these events led to increased public pressure on the tech industry to lower its environmental impact, leading to a wide adoption of Green IT practices. This phase is characterised by a rhetorical shift however: ICT is no longer framed as the problem, but is promoted as part of the solution. Unsurprisingly this phase is not developed by environmental protection agencies, but by industry. The reasoning behind the approach was that diminishing the impact of ICT itself would only have a small impact, whereas using ICT to make other sectors more sustainable was thought to have a major impact (Lennerfors, Fors and van Rooijen, 2015, p. 213). This 'greening by IT' instead of 'greening of IT' would consist of providing 'smart' solutions such as route planning, web meetings, virtualisation of servers and other forms of 'dematerialisation'.

The third phase, Sustainable ICT, broadens the scope even more, emphasising the potential of ICT to not only improve sustainability, but also economic and societal issues in the countries that can afford this (Lennerfors, Fors and van Rooijen, 2015). In practice this means other countries are burdened with the environmental footprint that the production of such ICT involves. Green IT and sustainable ICT translate lowering the footprint of ICT to lowering the electricity bill and nothing more. As the 2009 Global Action Plan *Green ICT Handbook* reads "BEING SUSTAINABLE SAVES MONEY (nothing is greener than the dollar!)" (Global Action Plan, 2009, p. 5). The report mentions that in 2008, wholesale energy prices increased by over 60% compared to the previous year, concluding "there are real savings to be made and quick wins to be had" (Global Action Plan, 2009, p. 6).

A similar reading of business practices related to Green IT is discussed by Majima et al. (2017) in *Green IT Did Not Take Place.* The authors describe how Japanese businesses approached Green IT as the rebranding of power saving strategies they were already practising (2017, p. 89). Fors and Lennerfors analyse the case of a Swedish IT company that, right after the mid 1970's oil crisis, build a heat recovery system into their 1978 data centre to save money. The company started to reinterpret its past at the moment Green IT started trending, reframing their heat recovery system as Green IT (Fors and Lennerfors, 2013). This reinterpretation of economic motives led to the company's rapid transition from regular business to sustainability leader (Fors and Lennerfors, 2018, p. 14). There is of course nothing wrong with reducing emissions while saving money, except if this means nothing else is done to make a business more sustainable and if efforts are only made when energy prices rise, such as in 2008, or worse, if this means sustainability efforts are dropped as soon as energy prices drop.[27] There is no real distinction between

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[27] Amazon for example, finally committed to a 100% renewable energy goal in late 2014 under public pressure. Yet, since then, it has expanded its data centre operations, but stopped all renewable energy investments after the 2016 wholesale electricity price dropped (Cook and Jardim, 2019, p. 4).

Sustainable ICT and regular ICT practices. Sustainable ICT can therefore be described as a business strategy used to gain a competitive advantage and its description matches Google, Amazon and Microsoft's 'sustainability' practices perfectly.

It is beyond the scope of this dissertation to perform an in-depth analysis of green, eco- or natural capitalism, but some relevant parallels between Sustainable ICT and natural capitalism can be drawn. Natural capitalism, as coined by Paul Hawken, Amory and Hunter Lovins in 1999, aims at resolving the ecological crisis by 'fixing' industrial capitalism by internalising certain externalities: incorporating 'natural capital' and pollution into the cost of commodities, rendering ecological responsibility profitable (Hawken, Lovins and Lovins, 1999). Nature becomes part of capital, so climate change can now be approached as an accounting problem, a flattening of land relations to resource relations based on a colonial world-view (Liboiron, 2021, pp. 62–63).[28] In both Sustainable ICT and natural capitalism, businesses are shaping the discourse and both obscure the relationships between climate change, endless economic growth and overproduction. Neither challenge the unsustainable business as usual of capitalism, on the contrary, both view the ecological crisis as a market failure, and capitalism's market system as the best and quickest way to deal with the crisis, a technical problem with many profitable solutions (Klein, 2014, p. 210; Wright and Nyberg, 2015, p. 113). Self-regulation and voluntary reporting, such as the Carbon Disclosure Project, are there to ensure no slow political processes stand in the way of efficient environmental action and, win-win, profits. Better still, the process is 'democratised' because ecological responsibility is now shared with the consumer, who can excise their power by consuming ethical products, and can indirectly subsidise the renewable energy of corporations through government subsidies and by assuming the environmental costs of computation at the edge of the network.

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[28] The incorporation of natural resources as part of capitalist production has been thought through before, but to opposite effect. Whereas Marx argued that capitalism required the looting of colonial countries by European capital in the process of primitive accumulation, Rosa Luxemburg argued that capitalist production continues to rely on the exploitation of natural resources and labour, and as market for consumer goods, in what we would now call the Global South, for the production of surplus value. In her analysis, capitalism relies on colonialism and environmental degradation. (Luxemburg, 1951, pp. 348–367)

Diverting attention from core to edge

It seems I am living on the edge–edge working, edge computing, both promising a lower carbon footprint. On closer inspection it only lowers corporations' footprint, overall energy use increases. First, I was told that the cloud was more green, because it is powered by renewable energy, and far more efficient than my old hardware. Software as a Service has made many people move their software and data from personal computers to the cloud, now caught in a vendor lock-in. When I'm in a video conference and my laptop is sucking dry the power grid to be able to keep up with the conversation, I'm being told it's more efficient when video conferencing and cloud service providers use edge computing because it lessens network traffic. Infrastructural sprawl increases and total energy consumption is going up either way. My energy provider installed a smart meter so I can gain insight into my usage and thus magically become more energy efficient. Climate change became my responsibility. Perhaps the smartness of the meter is its ability to distract from actual transformative practices by monitoring a crisis it is also contributing to (Gabrys, 2013, pp. 3–18)? It's yet another device on the edge of the network, consuming resources well before and after its use-phase, near future e-waste, increasing the need for bandwidth, increasing power consumption and the need to roll out more network infrastructure.

Edge computing and working from home are no solution to environmental collapse, it simply shifts responsibility away from those corporations with the largest footprint, an old strategy. It privatises and centralises (often once public) services, while outsourcing costs and responsibilities of care and maintenance. On a larger scale, it's classic capitalist extraction of value through the exploitation of free labour and resources, and greenwashing.[29] The earliest successful attempt to delay legislation by shifting responsibility to individuals, and predecessor to Sustainable ICT's greenwashing strategy, is the *Keep America Beautiful* campaign.[30] It was started in the 1950s by the disposable packaging industry in response to an attempt to introduce legislation to reduce waste.

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[29] Greenwashing is the purposeful misleading of the public about a company's environmental impact, making it seem more environmentally sustainable than it really is. It overlaps with the Marxist concept of false consciousness in its emphasis on processes that mislead people, except that its effect is not the concealing of the exploitation of labour, but that of the environment, by the ruling class.

[30] According to Noami Oreskes and Erik Conway, this strategy had been gleaned from the successful PR of the tobacco industry that positioned itself as a neutral player at the mercy of consumer demands (Oreskes and Conway, 2010).

Disposable plastic packaging became more widely used at the same time as the rolling out of the US Interstate Highways System, resulting in a growing amount of roadside garbage. Instead of attacking the problem of plastic waste by stopping the production of disposable packaging, the campaign placed the responsibility with consumers. Its motto: "People start pollution. People can stop it." (Schmall, 2023). The campaign resulted in 68 years of successfully delaying regulation. The strategy has become widely used. We are still reaping the rewards.

This diversion of attention to consumers and away from corporate responsibility was used by British Petroleum. It hired PR agency Ogilvy & Mather to develop a campaign blaming individuals for global warming through the concept of the carbon footprint (Kaufman, 2020). BP released its carbon footprint calculator early 2004, allowing people to assess the CO_2 released through their daily activities such as going to work. The tactic is almost an exact copy of that of the plastic packaging industry, shifting the responsibility of a problem of industrial scale, to citizens. As Mark Kaufman points out in *The Carbon Footprint Sham*, this idea was debunked during the pandemic, when people stopped travelling and carbon emissions only diminished by 8% (Kaufman, 2020). The Internet is gaining an increasing amount of carbon calculators and certificates, further entrenching the idea of the personal carbon footprint as opposed to the idea, dreaded by industry, of collective action to achieve policy changes and legislation, for system change.

Venues of resistance

These duplicitous campaigns have been exposed as PR tricks and propaganda, even so they have been incredibly effective. The idea of a personal carbon footprint, just like the concept of littering, became completely normalised. I will discuss the successes of these campaigns and the venues and value of resistance to them with help from Stengers and writer Philippe Pignarre's (2010) work *Capitalist Sorcery*. This 'pragmatic essay' as they call it, written five years after the anti-capitalist and anti-globalisation WTO protests in Seattle, 1999, is an attempt to think with the practices of those protesters, in order to understand what is inherited from them. They position themselves as 'sounders of the depths', and as such do not act as revealers of the truth or dictators of what to do next.

> "We cannot respond to the 'big questions', notably those that preoccupy the inheritors of Marx. We do not have any grand theory, but we do have the concern to find the words that are able not to crush the present under the challenge either to have to find a substitute for the working class or to contribute to its awakening." (Pignarre and Stengers, 2010, p. 109)

Their aim is to help protect the anti-capitalist struggle from that which threatens it. They do so through a pragmatic re-reading of Marx, describing capitalism as "a system of sorcery without sorcerers (thinking of themselves as such) [...]"(2010, p. 40), a system that depoliticises decision-making processes, a politics that kills politics. Stengers and Pignarre's 'pragmatic Marxism' places a strong emphasis on praxis. Instead of a general critique of capitalism, they offer concepts to experiment with, in order to re-politicise decision-making processes that are no longer considered political, an imaginative activism that gains momentum and strength through alliances and connections with others, an experimental approach to struggle. With this emphasis on praxis, their ideas edge close to anarchist practice and some of the ideas proposed by Graeber in *Fragments of an Anarchist Anthropology* (Graeber, 2004).[31] The step into the realm of magic and sorcery seems like quite a leap, but as will become clear in later chapters, the practices I describe require some protection from capitalist sorcery's infernal alternatives. They are too easily dismissed. The concepts introduced in *Capitalist Sorcery* are very productive when trying to analyse the lack of adequate response to the climate crisis and equally so when describing practices that experiment with doing technology otherwise.

Stengers and Pignarre are not the first to connect capitalism to sorcery. Marx also saw parallels. He described the bourgeoisie as "the sorcerer, who is no longer able to control the powers of the nether world whom he has called up by his spells" (Marx and Engels, 2002, p. 297). However, Stengers and Pignarre leave the realm of metaphor and argue that it is precisely the belief that magic does not exist that leaves us powerless to it. They differ from Marx in their analysis of capitalism's hold over people. To Marx it was achieved by the illusions spread through the ideology of the ruling class. Where Marx spoke of illusion, Stengers and Pignarre (2010, p. 52) prefer the word capture. Capture is not a matter of being blinded by ideology, that sits like a screen between the observer and reality, but it is the very capacity to perceive, think and feel that has been affected. To release its hold, it is not a matter of revealing the truth, lifting the screen, but of paying careful attention, and most of all of learning and experimenting.[32] The concept of capture is valuable to think through redefinitions of technology through small scale practices and experimentation precisely because it allows me to pay close attention to the specificity of situated practices and to words. I follow Williams, Fritsch, O'Connor and Thompson in arguing that words are symptoms of underlying and overarching social contradictions, the field of struggle on which strategies of resistance play out (Fritsch, O'Connor and Thompson, 2016). Stengers and Pignarre's proposal of praxis—of learning and experimenting—as resistance, rather than revolution (which could still be the result of it) creates an opening, a space for resisting capture through an opening up to possibilities and a willingness to think against the spell of progress.

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[31] Graeber rightfully traces the WTO protests to the organising that started in Chiapas, with the Zapatista uprising, something Stengers and Pignarre completely ignore (Graeber, 2004).

Thinking against this spell is of particular interest when discussing the positioning of technology within debates on environmental destruction (and practices dealing with this). Stengers and Pignarre (2010, p. 55) observe how the idea of progress as desirable is an especially powerful spell, justifying destruction in its name. All those who question destruction in the name of progress are instantly disqualified as reactionary. It is this sorting of innovation at whatever cost as good and looking back, repairing or maintaining as bad that makes people especially susceptible to capture. It is not about condemning progress, it can be defined in many different ways, but it is about being aware of this judgement that 'sorts' between rational and irrational, modern and archaic, in ways disconnected from political struggle. Stengers and Pignarre draw upon neo-pagan witch Starhawk, for an example of this 'sorting spell'. For Starhawk, using the word 'magic' is already an act of magic, because it triggers something in most of us, a smirk or a laugh, as something not to be taken seriously. What would a world in which progress doesn't authorise simplification look like? A world in which, for instance, the Luddites would not be dismissed as anti-tech, a take which simplifies their struggle and depicts it as a destruction of machines by ignorant workers, rather than a resistance against the loss of leverage to negotiate wages and working conditions due to automation.

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[32] In *Keywords for Radicals*, Fritsch, O'Connor and Thompson (2016) use the story of *The Emperor's New Clothes* to explain how revealing the 'true' nature of things doesn't necessarily lead to social change. After the child shouted that the emperor was naked, people kept pretending he was beautifully dressed for fear of losing their head.

This dismissal of any questioning of a new technology's deployment makes it nearly impossible to have meaningful political debate on technology and the climate crisis. This almost instinctual sorting into good and bad is the most powerful 'spell' the technology industry casts. 'Luddite' even became a curse word for people objecting to a new technology. Discussions around AI are a vivid example, although covering it in depth is out of the scope of this text. It is a technology that enchants and mesmerises people, and is tightly connected to the narrative of progress and technological innovation as good, natural and inevitable.[33] It is also tightly connected to the climate crisis because AI has a staggering environmental cost (Strubell, Ganesh and McCallum, 2019; Crawford, 2024). Those arguing for the regulation of AI because it results in the reproduction of systemic bias, spread of disinformation, enabling of mass surveillance, unethical military applications and environmental damage are heard, yet their objections currently do not lead to legislation. Not unlike the recuperation of environmental concerns into corporations' sustainability reports, concerns about AI are turned into corporate promises of responsible AI.

Any demand for measures taken (or practices aiming) to stop damage from being done by industry will be met with 'infernal alternatives'. This is how Stengers and Pignarre call situations in which there is only the choice of acceptance of business as usual, because taking measures would have disastrous results; or a hollow denunciation, hollow and powerless because, they argue, it results in the conclusion that the entire 'system' has to be destroyed, again leading to an impasse (Pignarre and Stengers, 2010, p. 24). Calls for social justice through specific measures are instantly confronted with the negative consequences of those measures and will be called unrealistic by those captured.[34] Requests for fair wages will be met with the argument that businesses will loose their competitive edge, resulting in workers losing their job. Demands for affordable COVID-19 vaccines through the lifting of patents will be met with the infernal alternative of the pharmaceutical industry not getting back their investment and becoming unable to invest in future vaccines for future pandemics. Examples of community organising that involves experimenting with environmentally less damaging network infrastructure are dismissed because it doesn't scale, is less efficient than Big Tech, is nostalgic and will never be adopted widely because it is difficult and no fun. When trying to argue, Stengers and Pignarre state, it is hard not to become trapped and define opposition in the terms fabricated by the infernal alternative. The practices I describe in the next chapters face these arguments but challenge dominant definitions of technology on their own terms.

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[33] The paper *Capitalist Magic* uses sentences from PR campaigns and speeches of tech evangelists that give expression to this idea of technology as a force of nature, and consumers as passive witnesses of the unstoppable march towards a time of abundance (see portfolio).

[34] This is reminiscent of Mark Fisher's (2009) description of capitalist realism. I chose not to build upon this concept because however accurate his description of the paralysis and the inability to think outside of the capitalist political-economic system, caused by this 'realism' is, his suggestion that anti-capitalism should have its own, authentic universality is at odds with my support for decolonial struggle and pluriversality.

> "[...] we think that words have a power. They can poison, imprison in dilemmas, provoke endless disputes. They can also create, make exist or confirm possibilities weakened by the poison of other words." (Pignarre and Stengers, 2010, p. 7)

In the face of infernal alternatives denouncing any challenge to capitalist exploitation, industry PR campaigns and corporate agendas dictating international policy making, it is hard not to despair and feel paralysed. *Capitalist Sorcery* is, however narrowly focussed on Europe and the US, a powerful counter-magic.[35] Its analysis of capitalism as a system of sorcery, requiring another type of attention, not one against illusion, but one towards the possible, makes space for the practices described in this dissertation. The cry of the WTO protestors, 'another world is possible', signifies a breaking of the spell, an escape from capitalist capture. Their cry, that should have been complemented with the Zapatista's 'a world where many worlds fit', is not repeated with the demand for a clear program of how this world should look, that would stop the potential for learning and infernal alternatives would be brought to the table. Yearning however, the writers argue, protects activists from these paralysing effects (Pignarre and Stengers, 2010). It is a matter, not of conversion to the right way of seeing, but of production, collective fabrication of alternatives, from ideas to processes and technologies.

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[35] *Capitalist Sorcery* is a Eurocentric work, which doesn't mean it is not useful to think with, but it must be thought with carefully and with awareness of its blind spots. The focus on Seattle for instance, doesn't include attention to the Zapatista movement that started the ways of organising that made the protest of 1999 possible (Couch, 2001; Graeber, 2004).

Words have a power and as this chapter has made clear, the word technology has become poison(ed), and uninhabitable to some, because of its internal contradictions. Technology is generally defined as the practical application of scientific discoveries, yet climate science hasn't been able to shift the tech industry's focus from shareholder value to facilitating degrowth in the Global North. The practices described in this dissertation experiment with doing technology otherwise, with "insistence of the possible against the pull of the probable" (Meek and Fontanilla, 2022, p. 274).

Conclusion

Edge computing promises endless streams of low latency game play and video streaming. It promises to help manage renewable energy, to be more energy efficient than data centres at the core and to reduce network traffic. On closer inspection, it is yet another example of capitalism profiting from the problems it creates, of neoliberal doctrine outsourcing burdens while privatising what was public, keeping centralised control over (once or again) decentralised infrastructures. Since the start of the pandemic the tech industry has seized the opportunity to profit from disaster and follow Airbnb into people's homes.[36] Web 2.0 introduced a business strategy that could, by giving access to the means of production of content, gain ownership over and generate profit from the product (Carr, 2006). While edge computing and remote working, users have to pay for access to, and buy elements of, the means of production, through the costs of electricity, hardware, heating and housing. As political theorist Jodi Dean puts it: "personal property becomes an instrument for the capital and data accumulation of the lords of platform" (Dean, 2020).[37] An escape from this capture is not easily imagined nor realised, as most people find themselves locked into Big Tech's platforms, relying on them for their livelihoods and social lives.

How can we resist the almighty lords of platform whose PR spin allows existing power structures to remain unchanged amidst the climate crisis, who have wedged themselves in between us and our work, between us and those we want to communicate with? Dean points out that current leftist dreams of small communities creating local commons, with a snarky mention of artisanal cheese, are in some sense elite. These dreams can only be realised by the few, are culturally specific and their localism expresses tendencies to, rather than resistance against, neofeudalism (Dean, 2020). A refusal of the silent creep of dispossession, an escape from the capture of vendor-lock in and a redefinition of technology and its role in the climate crisis, through the imagining and building of communal, more sustainable computational infrastructures, is a meaningful form of resistance though. Where Dean, in line with her Marxist views, is arguing for the emancipation of a multinational working class, I wish to introduce ecofeminist and anarchist practice alongside this struggle, building on the work of Salleh, Stengers, Pignarre and Graeber (Salleh, 1997; Graeber, 2004; Pignarre and Stengers, 2010).

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[36] AirBnB took hold of private property as a source of profit, by offering people the service of their platform, which allows the renting out of private homes to strangers. It extracts rent (and data) without property, through this process.

[37] Dean explains how capitalism is transforming into neofeudalism, with capital accumulation achieved as much through commodity production as through rent, debt, and force. "Digital platforms are the new watermills, their billionaire owners the new lords, and their thousands of workers and billions of users the new peasants." (Dean, 2020) Her analysis points to a new site of struggle, not that of production but of service work, and to the weaknesses of certain leftist ideas.

This chapter discussed why the word technology has become uninhabitable, giving rise to new terms expressing a different interpretation of it. It also established why it matters to pay attention to small scale practices which redefine technology's role in the climate crisis by looking into the role of technology in that crisis, and the response of the tech industry to criticism and the difficult position individuals and communities find themselves when trying to respond.

Even though scientific consensus about the anthropogenic cause of climate change existed early on, the corporate entanglement with the international response defused its potential impact. During the seventies, most notably due to *Limits to Growth*, the realisation that growth comes at great cost to the environment briefly led to the start of ideas on degrowth (Meadows *et al.*, 1972). Very soon after, due to corporate influence on international environmental policy, a legendary 180° pivot was made. At the start of the eighties growth turned from cause of environmental collapse, into necessity for environmental sustainability. High-income countries were the shining examples of how development meant decoupling economies from energy and resource overuse, ignoring the fact that any existing examples of such economies outsourced this to the Global South. Technology was meant to make this decoupling and dematerialisation a reality. The second twist reframed technology from part of the problem of overproduction to solution through CO_2 emission control. This discourse solidified the tech industry's position, gaining support from an extremely wealthy elite. It offered a tech fix to the climate crisis, which allowed power structures to remain in place. This has made a questioning of its role, as well as an effective response to the climate emergency, extremely difficult.

Despite this position, technology's own environmental impact has led to criticism and demands for more environmentally sustainable tech. Through a strong focus on CO_2 emissions and by outsourcing its responsibility to companies and consumers on the edge of the network, Big Tech defused criticism and has successfully delayed regulation. The rolling out of edge computing allows for not only less latency, but also for neat accounting tricks in sustainability reports. I discussed Google's 2020 sustainability report as a case study to evaluate how serious the desire for sustainability is at the corporate level. Google's net zero claim only holds up when emissions of data centers closer to the edge of networks are not included in the calculations. The renewable energy used is subsidised by the state and was meant to lower national emissions, yet now only covers additional consumption by multinationals. Google's self-assessment of risks and opportunities posed by climate change shows how it profits from its sustainable image. Climate change poses no real risks until total economic collapse. When analysing the discourse around sustainable technology, the same pivot can be seen as the one on the scale of the 'green economy': from ICT as problem to ICT as solution to the climate crisis. A closer look at the history of the tech industry's sustainability strategies in response to sustainability demands, from 1990 to now, made clear that Google's sustainability strategy is not unique. It is representative of the Tech Industry's general reframing of business as usual as sustainability.

The outsourcing of responsibility to the edge and a focus on emissions is not a new strategy. The individualising of a systemic problem has a historical predecessor in plastic packaging industry. Its latest iteration is that of the carbon footprint, distracting attention from the several industries and placing it on individuals. This rhetoric is taking hold on the Internet too, with more and more websites showing a calculation of carbon emissions associated with a visit to its pages. Individuals now find themselves responsible for 'littering' once again, this time with a CO_2 footprint. If only we didn't watch so many cat videos. The switch to Software as a Service moved control over data and the conditions under which it is stored and served away from users. The lords of platform now sit in between people and their work, people and their friends. Communication as means of production is in their hands.

What venues of resistance are there, against an industry which plays such a pivotal role in the discourse around the climate crisis, and which simultaneously occupies such a powerful position? Resistance seems impossible, but thinking with Stengers and Pignarre's concept of 'capture', and how to resist its hold, helps understand the value of breaking the spell by practising computing otherwise. The overall lack of public scrutiny of the tech industry's role in the climate crisis can be understood by viewing capitalism as a system of sorcery (Pignarre and Stengers, 2010). The tech sector is in such a privileged position because innovation, as part of progress, is hard to question because of capture, 'spells' immobilise the ability to think and paralyse collective action. Any proposal for practical measures that would hinder the economic growth paradigm leads to a confrontation with infernal alternatives. Any reinterpretation of technology's role in the climate crisis is met with a 'sorting spell' that instinctively dismisses anything that reeks of the past, of maintenance or repair. In the case of IT, two forms of capture are at play: the kind Stengers and Pignarre speak of and a technical capture, through a dependence on tech platforms, a vendor lock-in.

The greenwashing strategies of the tech industry I discussed in this chapter show that the refusal of individual responsibility for systemic problems such as climate change, is essential: holding those who lead harmful industries, and those governments aiding them, responsible by building up public pressure and demanding regulation and accountability. Here I depart from Stengers and Pignarre, who regard states as complicit in taking their population hostage. States are indeed complicit, but I agree with Andreas Malm, who in *Fossil Capital* argues that even though socialism would be of much greater help in the fight against climate catastrophe, there is no time to overthrow capitalism first and then act on the climate crisis; immediate action is essential (Malm, 2016). Rather than an escapist retreat, alternative practices which reimagine the infrastructures activists depend on to organise collective action—and which refuse to hand them over to the lords of platform—are needed. They challenge capture and pragmatically and experimentally perform other worlds. The term technology isn't representative of their practices, so they have chosen to invent new words which give expression to this difference. The next chapter looks at new terms that were coined in the 60s and 70s in attempts to redefine technology at the birth of the environmental movement.

Chapter 2

Soft Technology and Appropriate Technology

I was born two years before Soft-Tech was published, a publication bringing together articles about books, tools and products which editors Stewart Brand and James Baldwin promoted as a hands-on way to save the Earth (Brand and Baldwin, 1978). As a child I wore hand-knitted sweaters made from hand-spun and hand-dyed wool; I was given hand tools as birthday gifts; I cheered on my mother as she left to take part in anti-nuclear missile protests. My parents experimented with communal living, grew their own vegetables and we kept chickens in the attic and garden. When I started this research project, I couldn't help but notice how many ideas from my childhood were resurfacing today, especially the turn to environmentalism at a very small scale, in the neighbourhood and the home.[1] *I wondered if this played into the hand of the PR tactics I described in the previous chapter, where industry individualises systemic problems to escape accountability. It also made me hopeful that the connections between individual and systemic processes would finally be made. While growing up I couldn't understand how my own 'hippie' childhood experiences fitted into the advent of both the environmental movement and the digital revolution. During the pandemic, in between suffering through video-calls, I was anxious to explore how the generation of my parents, with their spinning wheels and compost heaps, ended up laying the foundations for both the environmental movement and its antithesis, the infiltration*

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[1] Not the chickens in the attic, that turned out to be quite unique.

of digital technology in every aspect of daily life, owned by a handful of publicly traded, multinational tech corporations. I will discuss what the practices I describe in subsequent chapters have inherited from those decades.

Introduction

In this chapter I look back to the 60s and 70s to find out what attempts to change technology's role in climate crisis were made in the decades before 'the pivot' from growth as cause to growth as solution to environmental decline became institutionalised. I will explore two early attempts to reposition technology in relation to the environmental crisis: soft technology, a view of technology as alchemical, allowing to produce more using less, and Appropriate Technology, aiming at repositioning technology in society based on different values than productivity.

In the first section I discuss the views on the relationship between technology, social change and the environment that were surfacing during the 1960s and 1970s. The counterculture and the start of environmental movement resulted in experimentation with different forms of activism and social organisation, in which technology played a key role. The movement was, among other things, a resistance against technocracy, the alienating bureaucracy of the military-industrial complex, of which the mainframe computer became a symbol. Countercultural activism differed from other movements, such as the New Left and Black Power, in its refusal of mainstream society, an escapism rather than a wish to transform it through strategic or institutional politics.[2] The countercultural view on how to achieve social change was influenced by cybernetics and Freudian psychoanalysis; resulting in experiments with forms of prefigurative politics in which technology, in the form of small scale tools, played an important role (Roszak, 1969; Turner, 2006).[3] These experiments gave birth to several new terms: convivial technology, liberatory technology, soft technology, biotechnic, Appropriate Technology, Alternative

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[2] Strategic politics is how sociologist Winnie Breines called politics committed to building organisation with the goal of achieving structural changes in the political, economic and social orders. She used this specific term to indicate a contrast with institutional politics, which ignored or excluded the 'radical goals' of marginalised communities. Strategic politics turns to civil disobedience and direct action rather than electoral politics. She used the term in the context of a study of the New Left (Breines, 1980).

[3] Prefigurative politics is a form of activism that models or performs in concrete actions and practice, the elements of the social and political changes that are sought. The changes start in the present, in concrete and local practices (Kothari *et al.*, 2019).

Technology and more.[4]

In the second section I take a closer look at the role soft technology played in redefining and repositioning technology historically. Soft technology represented a shift from the back-to-the-land communitarian lifestyle at the end of the 60s, to a technology-enabled, urban, individualistic lifestyle a decade later. Most of the ideas and products associated with it were based on an alchemical role for technology: it would allow for ephemeralisation, another word for decoupling, dematerialisation, efficiency or 'doing more with less'. This represents the same pivot as the one explored in the previous chapter, this time applied to the computer: from negative symbol of the technocracy, to a liberating symbol for decentralised social organisation and enabler of ephemeralisation. This resulted in the spread of a narrative sythesising two cultures: the back-to-the-landers, leaving society, and the technophiles, embracing the urban-industrial way of life. Soft technology didn't challenge the mainstream view on technology as enabler of economic growth, instead it challenged Appropriate Technology's push for degrowth. It promoted a technology enabled lifestyle activism, a precursor to ecomodernism and tech-utopianism and became the mainstream definition of technology.

In the last section I explore the slightly overlapping but notably different term Appropriate Technology (AT) and how people associated with it attempted to redefine and reposition technology. Appropriate Technology appeared similar to soft technology on the surface, but rather than lifestyle activism, was committed to communitarian anarchism, degrowth and citizen science. AT took inspiration from Gandhi's Swadeshi movement, with its resistance against large scale industrialisation as cause of environmental damage as well as form of imperialism. AT's promotion of renewable energy made the term successful internationally during the oil crisis, but the anti-colonial origins were lost and it ended up being appropriated for its opposite. Applied in the Global South, AT turned into colonialism by other means, while in the Global North it was an attempt at bottom-up social organisation and degrowth which helped normalise recycling and renewable energy. Most experiments disappeared for lack of funding. However modestly, it did redefine tech; its communalist and degrowth aims were at odds with hegemonic notions of power, control and growth and it brought tech into the realm of citizen science and the communal home (and out of computer science departments). Technology was meant to be used at the service of biodiversity, limited resource use and social organisation, rather than allowing for unlimited economic growth. Its biggest shortcoming was not having a theory about why certain tech became dominant, which could have informed practitioners' activist strategies. Internationally AT was dropped as soon as oil prices dropped and ephemeralisation, supporting the myth of 'green growth' became the dominant ideology.

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[4] Descriptions of these terms can be found in this chapter and in the *Damaged Earth Catalog* (see portfolio).

Social change, technology and the environment in the 60s and 70s

During the 1960s and 1970s there was a wave of environmental activism in response to a feeling of urgency in the face of environmental collapse, comparable to today's. The publication of several key books triggered the start of the environmental movement: *Silent Spring* by Rachel Carson, from 1962, *The Population Bomb* by Paul and Anne Ehrlich, from 1968, *The Closing Circle* by Barry Commoner, from 1971, and *The Limits to Growth* by Donatella Meadows, Dennis Meadows, William Behrens and Jørgen Randers, from 1972. These books made scientific research dealing with the impact of industrial society on the environment accessible to the public and created a new awareness about problems resulting from industrial waste, pesticide use, a growing world population and the finite availability of resources sustaining modern life.[5] *The Limits to Growth* had a big influence on the perception of wealthy industrialised nations, which were suddenly perceived as the main instigators of environmental degradation. For the first time political parties and international institutions with an environmental focus, such as the United Nations Environment Programme (UNEP) discussed in the previous chapter, were founded.[6] However, not all responses to the environmental crises took the road of international politics. A grassroots resistance was brewing, the source of both terms this chapter explores. To situate these two terms and practices, the counterculture merits a closer look.[7]

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[5] These books represented different, sometimes incompatible, views on the cause of the environmental crisis. Author of *The Population Bomb* Paul Ehrlich for instance, was very critical of Barry Commoner's *The Closing Circle*, because it pointed to capitalist technologies as cause, rather than overpopulation. Commoner responded to this criticism by pointing out that *The Population Bomb* placed the cost of overpopulation with poor nations, a situation resulting from their previous exploitation under colonialism, and that any type of population control, as opposed to voluntary action, would involve political repression (Commoner, Ehrlich and Holdren, 1972). Ehrlich was Stewart Brand's professor at Stanford.

[6] Founded by a leading figure in the oil industry.

Countercultural resistance

The 1960s was a very turbulent decade that saw an explosion of protest movements in the US and Europe, among which the New Left, Black Power and anti-Vietnam-war movements. Historian Theodore Roszak was the first to gather a set of relatively new phenomena happening alongside and mixed with these political protests; a psychology of alienation, oriental mysticism, psychedelic drugs and communitarian experiments; under the umbrella of one word: the counterculture (Roszak, 1969).[8] It didn't concern one movement or phenomenon but a multitude of individuals, initiatives and groups temporarily coalescing around a set of shared goals and ideals (Bennett, 2012). It refers to only a tiny minority of young people, excluding the conservative, liberal, old-school Marxist and activist Native American and black youth that organised themselves through institutional or strategic politics. The countercultural youth didn't turn to either type of political organisation for social change, even though there were some overlaps with the activism of the New Left. Among the countercultural youth there was a general disillusion with politics, which to many represented the technocracy's rule by experts and subsequent alienation.[9]

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[7] The term counterculture was coined by Talcott Parsons in 1951, but he did not provide a definition. In 1960 Milton Yinger defined the term contra-culture as to distinguish a type of social group that is in value-conflict with the dominant society, from a subculture. Since then, many have used the term counterculture with differing interpretations. Theodore Roszak was the first to provide a comprehensive definition of the US counterculture of the 1960s (Roberts, 1978).

[8] In this section I build upon the research of Roszak, who provides an account of the counterculture, written as it was happening from the perspective of a participant-observer. His account is valuable in this context because of this historical and personal closeness. He distinguishes the social movement he studied from a subculture by naming it the counterculture, emphasising the refusal of, and disaffiliation with, society and mainstream culture. For him this refusal did not happen only on the level of style and expression, such as in a subculture, but was a spiritual as well as a political movement "seeking to ground democracy safely beyond the culture of expertise" (Roszak, 1969, p. 265; Hebdige, 1979). Roszak's account of the counterculture is significant when analysing the confrontation between environmentalism and industrial capitalism in the practices around AT and soft technology, because of his commitment to describing the counterculture as a movement rather than an already assimilated and soon to be commodified subculture.

[9] This section briefly situates the core of this chapter (the analysis of soft technology and Appropriate Technology). I combine two complimentary accounts of the US counterculture's relation to computing and technology, that of Roszak and of Turner, which I contextualise in the footnotes. I start the chapter with broad strokes which become increasingly fine grained, drawing in texts and publications from these decades, culminating in my own account.

The countercultural youth resisted the technocracy, which Roszak defines as a social form in which an industrial society reaches the peak of its organisational integration. With this he meant the implementation of ideals such as modernisation, updating, rationalising and planning through imperatives such as efficiency, social security, large-scale coordination of men and resources, to achieve ever higher levels of wealth and manifestations of power. This included the implementation of social engineering to orchestrate the entirety of the human context within industrial society: politics, education, leisure, entertainment, culture as a whole, including people's unconscious drives and even protest against the technocracy itself (Roszak, 1969, p. 6). In Roszak's view these emerging technocratic paradises were more stable and effective than even Aldous Huxley and George Orwell foresaw, not least because they "denature the imagination by appropriating to itself the whole meaning of Reason, Reality, Progress, and Knowledge", making it "impossible to give a name to unfulfilled potentialities but that of madness"(Roszak, 1969, p. xiii).[10]

This observation closely resembles Stengers and Pignarre's (2010) analysis of capitalism in *Capitalist Sorcery*. He describes the same judgement that 'sorts' between rational and irrational, modern and archaic, in ways disconnected from political struggle. Traditional forms of resistance were failing because they were based on antiquated categories such as Republicans and Democrats, Tories and Labourites, which dealt with many political issues except the technocracy because it was not perceived as a political phenomenon. Again a connection to *Capitalist Sorcery* can be made; in which Stengers and Pignarre describe a system that depoliticises decision-making processes, a politics that kills politics. Like Pignarre and Stengers describing capitalism's spell of unquestionable progress, Roszak (1969) describes technocracy as a cultural imperative beyond question or discussion. To Roszak, the counterculture was about bringing down this cold war military-industrial bureaucracy with an LSD infused cocktail of personal exploration and political protest (Roszak, 1969; Turner, 2006).[11] The counterculture was resisting capture, thinking against the fairytale of progress.

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[10] To situate Roszak's account it is important to note that he was a Romantic, drawing on the work of Blake rather than Marx for an insistence on the value of imagination and alternative visions of reality as resistance to the technocracy's 'myth of objective consciousness' (Roszak, 1969; Partridge, 2018). He insists on the epistemological importance of subjective experience and like Stengers and Pignarre sees how this rejection of viewing the world with 'sober senses' allows "calling the myth of material progress into question"(Roszak, 1995 in Partridge, 2018, p. 26). For Roszak, Marxism is complicit in this myth of objective consciousness because of a lack of critique of science, and its endorsement of industrialism (Partridge, 2018). Similarly, Stengers and Pignarre question the relevance of Marx's faith in the 'sober senses' science would provide, with which the proletariat, freed from blinding ideology, would achieve class consciousness, in the present time (Pignarre and Stengers, 2010, p. 52).

This resistance wasn't led by the proletariat, but by a privileged, mostly white, middle-class youth. It was the first generation that experienced a more permissive childhood followed by a prolonged adolescence, delaying the responsibilities of adulthood. Yet after all this freedom and self-exploration, they had nothing but an ultra-conformist adulthood to look forward to. This development was accompanied by an enormous growth in the wealth of the middle-class. The financial safety-net this provided led to a growing number of young people opting to 'drop out'. They refused an education that was tailored to producing employees for corporations, rather than helping them explore their interests (Roszak, 1969). "At Cal you're little more than an IBM card" was the general feeling at the University of California in Berkeley, where the protests of the Free Speech Movement were sparked in 1964 (Mario Savio in Turner, 2006, p. 12). The university had become a knowledge factory and a microcosm of the rigid, highly rationalised military-industrial complex the protesters believed it served. In certain circles, the mainframe computer became a symbol of this depersonalised social order (Turner, 2006).[12]

Resisting the technocracy with technology

It wasn't through strategic politics that the countercultural youth imagined bringing about social change. They turned to the transformation of the self, a shift Turner (2006) 'blames' on the influence of cybernetics on the counterculture. The same military-industrial research world that developed nuclear missiles, also gave rise to a new understanding of the world as information system. Even though these theories had their origin in military technological systems developed during WWII, they were subsequently applied to an ever broader range of fields, at first biology and later sociology, psychology, economics and anthropology.[13] Norbert Wiener, Heinz von Foerster, Marshall McLuhan. Buckminster Fuller and Gregory Bateson popularised this cybernetic vision of the world and began imagining institutions as living organisms, social networks as webs of information, and information itself as the key to understanding the technical, social and natural world as systems (Clarke, 2012).[14] In these systems, the whole was constituted by self-regulating informational feedback loops between its parts and the environment, working against entropy, towards the stability of homeostasis. Since everything in such systems is connected through circular causality, individual elements are able to influence the larger whole and vice versa. Simplified, as it became in popular discourse at the time, this would mean the individual is connected to the entire universe and influences it as it influences them.[15]

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[11] Following in the footsteps of Roszak, media historian Fred Turner extensively studied the transformation of the *perception* of the computer from tool for rigid organisation and dehumanising bureaucracy of the cold war during the 1960s, into the means of societal transformation and personal freedom in the 1990s. In *From Counterculture to Cyberculture* (Turner, 2006) Turner traces the developments Roszak identified through to the 1990s and 2000s and focuses especially on the influence of cybernetic discourse on the legitimacy exchange that took place between the counterculture and the computing industry. His account is complementary to that of Roszak whose discussion centers on cultural influences such as literature and philosophy.

[12] Historian Joy Lisi Rankin challenges this narrative in *A People's History of Computing in the United States*, in which she describes how mainframe computers were used by communities at universities and colleges in time-sharing networks, providing important sites for early experiments with computing and networking (Rankin, 2018).

Roszak on the other hand points to the confrontation between Marx's and Freud's difference in assigning priority to the psychological and sociological categories as a way to understand the individual and society. Roszak discusses the influence of Freud on both Herbert Marcuse and Norman O. Brown, popular social theorists among the countercultural youth. Both, in very different ways, took on board the idea of the pathological as explanation for capitalist greed, a perspective which goes beyond an economic analysis of capitalism to a critique of capitalist society as repressive of fundamental human drives. Brown takes a more extreme position than Marcuse, and sees the struggle against repression not as a political struggle against social injustice, but as putting an end to all politics:

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[13] It is not within the scope of this text to discuss cybernetic discourse in depth, as it is but one influence in the historical development I'm describing. Orit Halpern's work *Beautiful Data: A History of Vision and Reason since 1945* discusses the history and impact of cybernetics on the human sciences, design, arts and urban planning and ultimately governance (Halpern, 2014). Writer Steve Rushton traces the evolution of cybernetic discourse through a study of the work of Gregory Bateson, and discusses how his philosophy was aiming at decentering the human as one element among many within a complex self organising system, a model for learning (Rushton, 2024).

[14] Their visions of cybernetics differed and evolved over time, such as the founder of cybernetic theory, Wiener, who championed automation as that which would free humans of hard and repetitive manual labour but a decade later started warning people of the dangers it could involve, such as dehumanisation (for instance when used in warfare) and potential subordination to machines (Hayles, 1999, pp. 85–86, p.107).

[15] This connection was made due to the popularisation of second-order cybernetics, a major shift away from information science into cybernetic theories of consciousness (Clarke, 2012). For a more in depth discussion see Clarke's (2012) *From information to cognition: The systems counterculture, Heinz von Foerster's pedagogy, and second-order cybernetics.*

> “The next generation needs to be told that the real fight is not the political fight, but to put an end to politics. From politics to poetry. ... Poetry, art, imagination, the creator spirit is life itself; the real revolutionary power to change the world.” (Brown in Roszak, 1969, p. 118).

The idea that the revolution that will free people from alienation must primarily be therapeutic[16] rather than institutional became increasingly popular and convincing others was not a matter of writing pamphlets or holding party meetings, but done through joy, art and inner transformation.[17] The countercultural youth, having lost their belief in institutional and strategic politics, turned away from these towards the transformation of consciousness as the trigger for social change. Cybernetic wholism is a near perfect fit with the Freudian turn to inner transformation, together providing a model for change in which individuals can model change. The New Left provided further inspiration. As sociologist Winnie Breines argues, the New Left’s prefigurative politics wasn’t apolitical, it resisted co-optation by the managerial anti-politics of the technocracy, and committed to participatory democracy, embodying anti-hierarchical values and community (Breines, 1980). This prefigurative politics, modelling the type of society you want to live in on a small scale, gave a sense of hope in a context where all hope of bringing about change through institutional politics had been crushed. It was a form of experimentation and learning, a resistance to the capture of technocratic sorcery.[18]

Parallel to this turn to prefigurative politics, there was a surge in environmentalism during the 1960s and 1970s which resulted in the formation of different views on technology, that featured so prominently that many of the new terms associated with these different lifestyles and ways of communal organising referred to technology or tools. Soft technology, tools for conviviality, Appropriate Technology, New Alchemy, Radical Technology, biotechnics, Intermediate Technology, Radical Hardware and liberatory technology are examples (Harper and Eriksson, 1972).[19] Most of these terms focus specifically on small scale tools. Somehow the countercultural ideals of inner change and simple living became mixed with high, yet small, technology such as stereos, slide-projectors and personal computers. The oil crisis made the energy intensive and polluting large scale technologies of industrialism, burning through massive amounts of fossil fuel, increasingly less palatable.

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[16] There is a lot to unpack here that is out of the scope of this text, not in the least the development of neo-Marxist thought, incorporating elements of psychoanalysis into Marxist theory. Bringing it back to environmentalism, technology and social movements, it connects to the work of Felix Guattari’s *Three Ecologies*, written in the same year as Roszak’s *Ecopsychology*, bringing together Roszak’s Freudian explanations and Turner’s cybernetic one through its building on Gregory Bateson’s *Steps to an Ecology of Mind* (Bateson, 1987; Guattari, 2000).

[17] One of the downsides of the idea that social change can be brought about by inner transformation is that it very comfortably translates to green consumerism, and holding the individual responsible for systemic ills, discussed in chapter 1.

[18] Unlike the New Left, which was a neo-Marxist movement, the countercultural youth were a more diverse group, which is why it cannot be characterised as an anti-capitalist movement. Roszak’s choice to call the movement anti-technocratic matches Breines’ analysis of the value of the New Left’s prefigurative politics as an expression of its relationship to power, in which organisation was never meant to come at the expense of democratic and direct participation.

Of big influence on this focus on small scale tools are, again, cyberneticians such as Buckminster Fuller, Marshall McLuhan, and Gregory Bateson, whose books and ideas featured prominently on the pages of the *Whole Earth Catalog*, circulating among a growing US readership in the late 60s and early 70s (Turner, 2006; Clarke, 2012). Buckminster Fuller's ideas especially expressed the philosophy behind this strange blend of environmentalist and tech-oriented cultures. He wrote about a tool-augmented man, the 'Comprehensive Designer', an individual who would recognise the universal patterns inherent in nature, design new technology in harmony with these patterns, making use of the industrial resources available to them and deploy these in everyday life. The world would be transformed through what he called 'comprehensive anticipatory design science'. It was based on a very top-down mode of analysis: first one had to understand the whole, then work on the parts (Fuller, 1965; Turner, 2006, p. 57).

The switch in the perception of computers, first as symbol of the technocracy, then as liberatory devices, was brought about in large part through the influence of the *Whole Earth Catalog*, which culminated in another publication, *CoEvolution Quarterly*, introducing the term soft technology to a larger audience. In the following section I will discuss this term, and contrast it with the ideas surrounding Appropriate Technology in the final section of this chapter. Even though these terms were at first used interchangeably, and each was interpreted and practised in many different ways, there are a few distinctions that are valuable for the further analysis of terminology surrounding practices trying to redefine technology today. These terms express two diverging views on technology in relation to the environmental crisis. Soft technology proposes an ephemeralisation of production processes, in essence uniting economic growth and environmentalism. Appropriate Technology on the other hand, embraces technology as part of economic degrowth, a technology at the service of biodiversity and communal organisation rather than industrial productivity. From all the terms that surfaced during these two decades, soft technology and Appropriate Technology have left the deepest trace on current (re)interpretations of technology.

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[19] The term degrowth, with its roots and inspirations in the Romantic movement of the mid 19th century, first appeared in the 1970s in response to, among others, the *Limits to Growth* report (Meadows *et al.*, 1972). It connects unlimited economic growth to environmental damage and aims to establish different measures of human development than increases in Gross Domestic Product. Degrowth is an alternative to Green Growth which is based on the decoupling myth (Hickel and Kallis, 2020). As a field of study it is tied specifically to economics and I will therefore not discuss it in depth.

Soft technology

> "The Whole Earth Catalog functions as an evaluation and access device. With it, the user should know better what is worth getting and where and how to do the getting." (Brand, 1968, p. 1)
>
> "This is a book of tools for saving the world at the only scale it can be done, one hand at a time." (Stewart Brand in Kirk, 2007, p. 43)

The term soft technology has an odd lineage that is significant to its influence on the present. Today and more generally speaking, the term refers to the intangible aspects of technology; not the hardware itself but deployment strategies for instance, or software in the world of computing.[20] In the 70s however, it referred to a specific use of technology. It concerned both older technologies such as wood burners and windmills, as well as the output of high-tech research and industrial mass-production such as solar panels and computers. The term was associated with the belief that these could be repurposed by individuals to serve local needs and ultimately, if enough people would transition to the use of 'good' technology, planetary health (Turner, 2006). The term stems from the UK, where it circulated during the early years of what is now known as the Alternative

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[20] The word 'software' was coined in 1958 and referred to the logical instructions for an electronic calculator: the routines, compilers and other programmed elements (Fuller, 2008).

Technology movement, which I'll discuss in the next section.[21] It got appropriated in the US and came to signify something quite different from its initial use.

The first mention of soft technology I could trace was in *Undercurrents* editor Peter Harper's *Soft Technology: a proposal for alternatives under conditions of crisis*, a Unesco grant application from 1971, and *Soft Technology: blueprint for a research community* by Robin Clarke, author of several books on the relationship between science and military technology and co-initiator of the *Soft Technology Research Community Project* (Harper, 1971; Clarke, 1972).[22] Three years later, it became a category in the *Whole Earth Epilog Teaser* (Brand, 1974, p. 6). Two years after that Stewart Brand and James Baldwin, made it the title of their 1978 publication *Soft-Tech*, in which they claimed to have used and defended it since the late 1960s (I couldn't find any mention of it in earlier issues of the *Whole Earth Catalog* however). I will use soft technology as the starting point to discuss the way small-scale technologies were featured in the *Whole Earth Catalog* (WEC) and it's successor *CoEvolution Quarterly* (CQ), because even though I do not believe that they defended 'soft technology' since the late Sixties (there was no other word used, apart from Appropriate Technology, for the specific approach to tools of the WEC and CQ before 1974) the fact that they started using it at that moment is significant. It indicates a shift or rift. By the time *Soft-Tech* was published, Brand and Baldwin had turned their backs on Appropriate Technology and with the embrace of the term soft technology, proposed and gave a name to their alternative to it.

Brand himself also traces the word's origin to the UK, where according to him it fell out of fashion and was replaced by Appropriate and Alternative Technology, but physicist Amory Lovins' *Soft Energy Paths* helped "revive the better language" (Lovins, 1977; Brand and Baldwin, 1978, p. 5). This embrace of a term revived by Lovins gives some indication of the new direction Brand and Baldwin are taking their audience.[23] Lovins uses the word soft technology to describe renewable energy technologies such as wind and solar. The first section of the introduction is titled “Technology Is the Answer! (But What Was the Question?)” and the overall premise of the book is energy efficiency combined with renewable energy as solution to the problem of resource scarcity, the same approach the tech industry promotes today (Lovins, 1977, p. 1). He is one of the founders of ‘natural capitalism’, an attempt at solving the ecological crisis by ‘fixing’ industrial capitalism by internalising certain externalities, discussed in the previous chapter (Hawken, Lovins and Lovins, 1999). He also published *Small is Profitable* and served on an oil industry lobbying group for 7 years (Lovins, 1977, 2002; Brown, 2015).[24] An article in *CoEvolution Quarterly*, Spring 1977, features him in conversation with Herman Kahn, physicist, founder of conservative think tank the Hudson Institute and one of the inspirations for Stanley Kubrick’s *Dr. Strangelove* (Brand, 1977).

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[21] In the UK a parallel development took place to the one in the US, under the flag of Alternative Technology. The Centre for Alternative Technology in Wales, *Undercurrents* magazine and the 1976 book *Radical Technology* were the most well known outcomes (Harper and Boyle, 1976). I will discuss some of these in the Appropriate Technology entry in this chapter. Robin Clarke's take on soft technology will resurface there too.

[22] Harper first used and defined the term soft technology in his grant application to UNESCO in 1971 (Clarke, 1972). He also coined the terms Alternative Technology and Radical Technology.

[23] It also gives some indication that they most likely didn't use or defend the term soft technology since the late Sixties, but only started using it after Lovins' book was published, one year before the publication of *Soft-Tech*.

This shift to a new term coincided with a shift that took place in the decade between the first edition of the *Whole Earth Catalog* in 1968 and the publication of *Soft-Tech*, exactly a decade later. Where the WEC focused on products, tools and books that could interest a target audience of back-to-the-landers, in *Soft-Tech* the focus is clearly on products that can be used as part a more mainstream urban or sub-urban life (Turner, 2006).[25] *Soft-Tech* is written after the collapse of many communes and the end of the back-to-the-land movement in the US. Brand’s shift to more mainstream consumer goods in CQ reflects the settling down of many involved in the counterculture (Turner, 2006). In 1971, Brand wrote about how his friends, 3 years earlier, were “starting their own civilisation hither and yon in the sticks”, which inspired him to start his *Whole Earth Truck Store*, driving a Dodge pick-up from commune to commune, offering a selection of products and books, the predecessor of the WEC (Brand, 1971, p. 439). In 1978 Brand (1978, p. 5) made this break with earlier ideals of self-sufficiency crystal clear in his article *Local Dependency* in which he decries "Self-sufficiency" as an idea which has done more harm than good and is a "damned lie" because "there is no dissectable self". Instead he argues for local dependency (echoing McLuhan):

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[24] The title riffs off Schumacher’s *Small is Beautiful: Economics as if People Mattered* (Schumacher, 1973).

[25] Turner calls the audience of the WEC, the sub-group of countercultural youth that turned to technology and a change in consciousness as primary drivers of social change, the New Communalists. He states other historians have often depicted the counterculture as a movement that got co-opted by the forces of capital, technology and the state, yet he claims the New Communalist wing embraced mainstream military-industrial academic research practices early on, including their celebration of technology and cybernetic discourse (Turner, 2006, p. 33). He warns not to confuse the New Communalists with the New Left or the entire counterculture with either, because it could lead to the idea that there was once an authentically revolutionary social movement that was co-opted by capitalism, and that a revival of its peer-to-peer technologies could bring it back. It is exactly this distinction I aim to make by looking into two terms rather than one and take these different practices seriously in their diversity.

> "And since our world is increasingly cultural, and proportionally ever less physical, the meaning of 'local' is not geographic, at least not only." (Brand and Baldwin, 1978, p. 5)

Brand took his old Stanford teacher Paul Ehrlich's theory about biological co-evolution and used it as a metaphor for a new way of life, inspired by the work of former anthropologist, psychiatrist and biological researcher Gregory Bateson, whose second-order cybernetic vision was very present in the pages of CQ. Paul Ehrlich, mentioned earlier in this chapter as author of *The Population Bomb*, was a Stanford biology professor. Through him Brand encountered systems-oriented ways of thinking.[26] Erhlich applied systems-oriented approaches to evolutionary biology (Turner, 2006: p. 43). For Ehrlich, and subsequently Brand, cultural activities such as politics and art were significant because through it, humans can recursively influence their biological development. Artists such as John Cage were expressing similar ideas: "the highest purpose [of an artist] is to have no purpose at all. This puts one in accord with nature in her manner of operation." (Turner, 2006, p. 47). The idea that the world is a system and its inhabitants are potentially influential elements of that system fitted the New Communalist's return to the mainstream perfectly. Nobody can live outside the system and so counterculture and society have to co-exist and co-evolve (Turner, 2006, p. 123).[27] New words were needed to describe this.

In *Soft-Tech*, Brand remarks that even though cynicism and despair are everywhere, there is also something else: attention to detail. It is a form of caring to do things well, and to him this often meant doing it yourself. In order to start doing it, the reader can browse the different categories of the book: tools, inventions, solar, wind, transport, steam, biofuels, building and integrated systems. It features books such as *Home is Where you Park it: a guide to RV living as a life-style* and *Living Aboard: the cruising sailboat as a home* and products from small tractors to many different types of wood stoves and solar heaters (Brand and Baldwin, 1978). Many of these wouldn't look too out of place in hipster magazines today. And they don't, there are hipster magazines today featuring exactly these types of nomadic and sustainable-at-first-glance tools and products: tiny homes and van life, electric bikes and solar panels abound for those who can afford it. It's all about modelling change through the consumption of goods, about buying the right products. Brand writes he doesn't want to inspire anyone; it's not a religion but a practice and as such it only needs to be imitated by others in their own way. An imitator is better than a convert, he concludes. This reflects the ideal of remaking the world not through politics but through technology enabled exemplary ways of life (Turner, 2006, p. 247). CQ's last issue was published in 1984, its influence is omnipresent today, as I'll explore in the next section.

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[26] Systems theory is a field of study, with applications in ecology, management and social sciences among others, that views the behaviour of a complex system as the effects of relations between different elements of a larger whole. It is based on the premise that complex systems are more than the sum of their parts and therefore the relationships between parts are studied to gain a better understanding of the whole (Von Bertalanffy, 1969). Buckminster Fuller was a systems theorist.

[27] This return to the mainstream meant soft technology and CQ were catering to a subculture rather than a counterculture (Roszak, 1969, p. 265; Hebdige, 1979).

Soft technology's main characteristics

The book *Soft-Tech* doesn't clearly define soft technology. The introductory texts by the editors Brand and Baldwin give some indications however.[28] Brand defines soft technology negatively, as not administrative, and as opposite to Appropriate Technology. Baldwin (1978) defines it as the hands-on practice of a group of people who want to use technology to augment natural systems. He condemns the anti-tech attitudes of some environmentalists as wanting to return to the past, a time when people had much worse attitudes towards nature, "[e]ven the Native Americans did their share of damage" (Brand and Baldwin, 1978, p. 5). He gives the Space Colony argument as an example of a hopeful broadening of the discussion around technology.[29] Thorough discussion with multiple interest groups about how to go forward are but an obstacle to him: "All that talk can be paralysing, yet it is a time for action" (Brand and Baldwin, 1978, p. 5) He celebrates the hard working do-ers and makers who risk all their money and time, get their hands dirty and do their homework, meaning learning about technology.[30] Ultimately, soft technology is about ephemeralisation, an idea introduced by Buckminster Fuller, a process of technological development which allows more and more to be done with less and less, an "ephemeralizing-toward-pure-energy progression" (Fuller, 1938, p. 259). Even though it wasn't meant to be a religion, soft technology requires a steadfast belief in the alchemical, in ephemeralisation, or 'dematerialisation' and decoupling, enabled by technology.[31] It normalised and popularised this way of thinking about technology, which would become the cornerstone of (inter)national environmental policy in relation to the climate crisis.[32]

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[28] Baldwin worked with Buckminster Fuller in the 1950s, and was visiting lecturer in design at Southern Ilinois University at Fuller's invitation. He worked at the Farallones Institute, the New Western Energy Show, the California Office of Appropriate Technology, and with the New Alchemists.

[29] The Space Colony argument Baldwin refers to is the idea to build space colonies orbiting the earth for the purpose of asteroid mining and to provide 'space' for the growing population. The colonies would harvest solar energy that would be beamed back to earth. The idea was popularised by physicist Gerard O'Neill.

An even more thorough outlining of the concept is provided by a reproduction of a list compiled by Robin Clarke, taken from the pages of the summer 1972 edition of *Undercurrents* magazine. It is called *Some Utopian Characteristics of Soft Technology.* In 35 points the characteristics of a 'HARD' and a 'SOFT' technology society are given (figure 2.1). However, the utopian society outlined in Clarke's list is not reflected in the pages of *Soft-Tech*, which only focuses on tools and leaves out the social organisation at the heart of Clarke's description. Not democracy, nor the integration of science and technology in culture, but getting things done is the focus of *Soft-Tech.* With Buckminster Fuller's alchemical promise of ephemeralisation in mind, Baldwin and other soft technologists "[...] see a future in which technology is steered with an eye towards helping to make Experiment Earth a success." (Brand and Baldwin, 1978, p. 4) They appropriated the term soft technology, emptied it of its political content, and poured their own entrepreneurial, space colonising, tech-solutionism into it, promoting a 'hip' consumer activism.[33]

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[30] This sentiment is echoed almost literally in transhumanist and anarcho-capitalist Patri Friedman's opening speech at the Breakthrough Philanthropy event in 2010, quoted in the paper *Capitalist Magic* (see portfolio). This celebration of the fearless and hard working tech-entrepreneur working on fixing the big problems of the day, a modern saviour, is still very much alive today. As Richard Barbrook and Andy Cameron phrased it: "These restyled McLuhanites vigorously argue that big government should stay off the backs of resourceful entrepreneurs who are the only people cool and courageous enough to take risks" (Barbrook and Cameron, 1995).

[31] Baldwin recounts getting into soft technology by building dragsters, light racing cars with a small motor, until he met Fuller at the age of 18, who used the word ephemeralisation, which 'clicked' for him. (Brand and Baldwin, 1978).

[32] For an in-depth discussion of the rift between materiality and information which evolved from the early days of cybernetics to today, see *How We Became Posthuman* by Katherine Hayles (1999, pp. 192–220). For an in-depth discussion from an (eco)feminist perspective on the mind-body split at the core of the ideology of immateriality, please see the work of Ariel Salleh, Carolyn Merchant and Elizabeth Grosz (Grosz, 1994; Salleh, 1997; C. Merchant, 2019).

Rather than using large scale destructive technology to kill, soft technologists would use small-scale technology to fix the environmental crisis. At first this concerned mostly wood stoves, LSD and slide projectors, but with the arrival of the microcomputer in the late 1960s and early 1970s something shifted. A new narrative was created and promoted, most fervently by Brand, speaking of a new type of computer engineer, the 'guerilla hacker' of the west-coast anti-war movement, who, aided by this narrative, gave the computer a new image and political orientation (Roszak, 1986; Barbrook and Cameron, 1995; Turner, 2006; Rankin, 2018).[34] Drawn into this narrative were meet-ups such as the Homebrew Computer Club and projects such as Community Memory, examples of the influence of Schumacher's *Small is Beautifull* and Ivan Illich's *Tools for Conviviality.*[35] Both projects build a community of interest with a dose of playfulness and fun, all on a low budget (Schumacher, 1973; Illich, 1973).[36] The 'guerilla hackers' were prime examples of the WEC's ethos: self-reliance and pioneer adventure on the digital frontier (Barbrook and Cameron, 1995). For them, information was more than an industrial necessity or commercial commodity, it was the lifeblood of democratic politics. With the arrival of the 'guerilla hacker' narrative, the computer, at first the very symbol of the technocracy, was more and more seen as its antidote, as long as its power was universally accessible (Roszak, 1986). This 180° pivot prefigures the one I described in the

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[33] Not only did the legitimacy exchange Fred Turner describes in *From Counterculture to Cyberculture*, building upon work by Geoffrey Bowker, grant the New Communalist movement some of the legitimacy of the scientific research community, it also helped legitimate consumerism of tech products as hip (Bowker, 1993; Turner, 2006).

[34] Rankin challenges this narrative by providing a careful examination of the history of computing as it was developed in schools and at universities in the US, by communities on time-sharing networks. Her account emphasises community, creativity and collaboration rather than individual genius and competition, and demonstrates how a lot of innovation stemmed from people sharing computers with a community rather than from personal computer use (Rankin, 2018). Other histories, contesting the 'guerilla hacker' narrative are Nathan Ensmenger's *Beards, Sandals, and Other Signs of Rugged Individualism: Masculine Culture within the Computing Professions* and Janet Abbate's *Recoding Gender: Women's Changing Participation in Computing* (Abbate, 2012; Ensmenger, 2015).

[35] *Tools for Conviviality* was a book about a pluralism of responsibly limited tools that would help create a future society both very modern yet not dominated by industry, which recognises natural scales and limits (Illich, 1973). *Small is Beautiful: Economics as if People Mattered* proposes an economics of 'enoughness' that respects natural limits and makes use of Appropriate Technology (Schumacher, 1973).

[36] The Homebrew Computer Club was a group of electronics hobbyists interested in building computers, exchanging parts and expertise. The Club gathered some people that became very influential in the Silicon Valley tech industry. Community Memory was the first public Bulletin Board System (BBS), started in 1973, with a terminal in a Berkeley record shop where people could leave and retrieve messages. It was an early experiment to see how people would react to exchanging information via a computer.

Table 2.1: Some Utopian Characteristics of Soft Technology, by Robin Clarke (1972)

‘HARD’ technology society	’SOFT’ technology society
1. ecologically unsound	ecologically sound
2. large energy input	small energy input
3. high pollution rate	low or no pollution rate
4. non-reversible use of materials and energy sources	reversible materials and energy sources only
5. functional for limited time only	functional for all time
6. mass production	craft industry
7. high specialisation	low specialisation
8. nuclear family	communal units
9. city emphasis	village emphasis
10. alientation from nature	integration with nature
11. consensus politics	democratic politics
12. technical boundaries	technical boundaries set by nature
13. world-wide trade	local bartering
14. destructive of local culture	compatible with local culture
15. technology liable to misuse	safeguards against misuse
16. highly destructive to other species	dependent on well-being of other species
17. innovation regulated by profit and war	innovation regulated by need
18. growth-oriented economy	steady-state economy
19. capital intensive	labour intensive
20. alienates young and old	integrates young and old
21. centralist	decentralist
22. general efficiency increases with size	general efficiency increases with smallness
23. operating modes too complicated	operating modes understandable by all for general comprehension
24. technological accidents frequent	technological accidents few and unimportant and serious
25. singular solutions to technical and social problems	diverse solutions to technical and social problems
26. agricultural emphasis on mono-culture	agricultural emphasis on diversity
27. quantity criteria highly valued	quality criteria highly valued
28. food production specialised industry	food production shared by all
29. work undertaken primarily for income	work undertaken primarily for satisfaction
30. small units totally dependent on others	small units self-sufficient
31. science and technology alienated from culture	science and technology integrated with culture
32. science and technology performed by specialist elites	science and technology performed by all
33. strong work/leisure distinction	weak or non-existent work/leisure distinction
34. high unemployment	(concept not valid)
35. technical goals valid for only a small proportion of the globe for a finite time	technical goals valid ’for all men for all time’

previous chapter, the one taking place in the 1980s on an international scale, where the narrative around technology (and economic growth) transformed it from cause of, to solution to global environmental depletion. Even though this narrative has been contested by many leading academics, it still persists to this day.[37]

The narrative of the 'guerilla hackers' of the 60s and 70s seemed to synthesise two contradictory views. Where Roszak describes this as a merge of views, Turner, borrowing from Bowker, speaks of a more strategic dynamic: legitimacy exchange. Roszak identifies the 'reversionary' view, aiming at moving away from industrial society, first expressed by the Romantics in the mid-19th century. Socialist leader and artist William Morris for example, envisioned a future that recreated an idealised pre-industrial past with an economy based on handicrafts and governance through informal communal arrangements (Roszak, 1986). On the other side Roszak places the 'technophiles' that fully embrace the urban-industrial system with its advancement of science and technology that would lead to the mastering of nature. The 'guerilla hackers', the narrative goes, wanted it both ways. The computer terminal would feature as "a type of hearth or camp-fire around which, by way of their modems and satellite transmitters, the clans gather to exchange gossip and graffiti with their counterparts half a world away" (Roszak, 1986, p. 147). Roszak, even though intending to critique this narrative, unintentionally perpetuated part of it, by arguing these two views came together in the 'guerilla hacker'. This narrative helped spread the belief that new technology contained in a communitarian context would lead to a humanly scaled and non-hierarchical society with a decentralised governance, based on equal access to information, made possible by the computer. Information would equalize and flatten hierarchies, like the original editors of *Radical Software* worded it in its first issue:[38]

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[37] For an in-depth analysis of this narrative, please see the work of Rankin, Ensmenger and Abbate, among others (Abbate, 2012; Ensmenger, 2015; Rankin, 2018). Barbrook and Cameron explore this mix of "cybernetics, free market economics, and counter-culture libertarianism" in *The Californian Ideology* (Barbrook and Cameron, 1995). I explore the persistence of the myth of the male genius tech entrepreneur in *Capitalist Magic* (see portfolio).

[38] *Radical Software* was a 1970s journal exploring experimental video as political medium, outside of broadcast TV control. Inspired by cybernetics, their vision was that giving people access to the tools of production and distribution of media, and control over the content, would help accelerate social and cultural change. For an in depth discussion on this and the role of feedback in the practices of the communities around the magazine, see *The Fabulous Loop de Loop (Floop): A cybernetic discourse as read through seven feedback machines* (Rushton, 2024).

> “Power is no longer measured in land, labour or capital, but by access to information and the means to disseminate it.” (Gershuny and Korot, 1970, p. 1)

Lee Felsenstein, the creator of the Osborne portable computer and founder of the Homebrew Computer Club and Community Memory recounts, in an interview with Turner (2006, p. 114), how Brand “set up an alternate temple of the same religion, of the church of technology, telling people in technological society that people needed to learn to use tools.” For him the WEC meant “you don’t have to leave industrial society, but you don’t have to accept it the way it is.” (Turner, 2006, p. 114). This technological utopianism is later echoed by tech evangelists’ promotion of AI, which I explore in my paper *Capitalist Magic*, in which technology eventually features as something Brand and his colleagues helped spark but claimed they were trying to avoid, as literal religion (see portfolio). Soft technology represents this unlikely merge of environmentalism and modern industrial discourse which would eventually lead to a type of environmentalism embracing geo-engineering and nuclear power: ecomodernism.

Soft technology and the dominant definition of technology

> “The other day it hit me. The key. They always refer to it not as an appropriate technology, but as Appropriate Technology. The big A and the big T, sometimes AT. In simply altering a lower case to an upper case, we go from experience to belief. [...] There are elements of a religious revival in Appropriate Technology. It is a strange melange of Marxism, Puritanism, and something called Buddhist Economics.” (Witold Rybczynski in Brand and Baldwin, 1978, p. i) [39]

After closer inspection of the term soft technology and its strange lineage it becomes clear that the term doesn’t challenge dominant definitions of technology at all, it challenges alternative definitions of it. The book is so clearly positioned as the opposite of Appropriate Technology, there must be a fundamental difference between the two with a lot at stake, seemingly almost personally, for Brand and Baldwin. When Brand reflects on Rybcynski's insight into what was wrong with AT, Brand reflects: "Here he is carping away like every saint in history long-lived enough to see his technique decay into a belief." (Brand and Baldwin, 1978, p. i) Rybcynski's argument is twofold: first of all he states most of the technology promoted by AT simply doesn't work and secondly it is a project by wealthy nations introducing technology that isn't used domestically to low-income countries. He wonders if it isn't a neo-colonialist trick and claims the movement has very little to offer in terms of actual problem solving.[40] Soft on the other hand, responds Brand, is "alive, resilient, adaptive, maybe even lovable" (Brand and Baldwin, 1978, p. 5). It may have been easy to love, meaning easy to accept its narrative as truthful, since it didn't propose anything that different from mainstream views on technology.

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[39] Rybcynski is an architect whose work for the Minimum Cost Housing Group made him visible in many Appropriate Technology publications. His book *Paper Heroes: a Review of Appropriate Technology* gave a critical account of the movement (Rybczynski, 1980).

What was at stake for Brand and Baldwin was the incompatibility of their ideal of the tool-augmented man fixing the environmental crisis with his bare hands on the keyboard of a computer or a geodesic dome, decoupling environmental depletion from economic growth through ephemeralisation, with the 'administrative' attempts of AT, as applied by governments of the Global North to aid rural populations in low-income countries. Their take on technology came from an entrepreneurial, white, educated and rather masculine world that promoted a tech-utopian, ecomodernist view, popularising cybernetic theory and the power of tech to foster social change, lending a 'cool' image to mainstream technology (Barbrook and Cameron, 1995; Turner, 2006; Ensmenger, 2015; Rankin, 2018). Yet AT as taken up by government agencies was concerned with solar cookers and water pumps for Indian or Mexican women living in rural areas, a polar opposite.[41] There is a lot to say about this in relation to neocolonialism and gendered applications of technology, but rather than brushing over differences, I will unpack the different applications of the term Appropriate Technology, including those which concerned Rybcynski, in the next section. I'll explore the core of the clash between AT and soft technology, to understand if any redefinitions of technology were brought about by the birth of the environmental movement.

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[40] As I'll discuss in the next section, Rybcynski has good points there, even though he generalises about a collection of different practices.

[41] The first page of *Soft-Tech* features a 1915 postcard with a photo of two Berber men from the Rif valley in Morocco, who are milling olive oil with a big millstone. The text beneath mockingly states that AT is like a millstone to people in "underdeveloped countries", it then insinuates that this milling technology seems quaint to us and the Spanish coloniser in 1915 but is torture to the men in the picture. They even link it to Rif insurrections against the Spanish, oblivious of the fact that olive oil milling using these types of mills goes back centuries and is an integral part of Moroccan culture (Brand and Baldwin, 1978, p. i).

Appropriate Technology

Appropriate Technology did have something to do with colonialism, but (initially) not in the way Rybczynski meant. In the beginning it was very much an anti-colonial endeavour. It has its roots in the work of Mahatma Gandhi in the 1920s and 1930s, whose ideas on development were that India's survival relied on village industries, because that is where most Indians resided. He stated "the poor of the world cannot be helped by mass production, [but] only production by the masses" (Schumacher, 1973, p. 153). According to Gandhi, large-scale urban industries needed to become subservient to small-scale village industries, rather than the former destroying the latter. Technology should serve the majority of people, not put them out of work. His ideal technology was the spinning wheel, which symbolised freedom and self-reliance (Akubue, 2000).[42]

Gandhi's ideas found their way into the writings of economist Ernst Schumacher (1973), who wrote the book *Small is Beautiful: A Study of Economics As If People Mattered* in 1973, proposing an economy of enoughness, mindful use of non-renewable resources, respecting the limits of how much environments can absorb pollution and focused on local production for local needs using technology applicable to the scale of the community.[43] Schumacher served as economic advisor to the British National Coal Board (BNC) when he observed that it was due to the large scale of the organisation that the BNC had such an uncaring attitude towards miners who suffered from black lung disease. While he worked as economic adviser for the UN in Burma he discovered Buddhist economics and the work of Gandhi, who he called the greatest economist of the 20th Century (Akubue,

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[42] Gandhi gave force to the Swadeshi movement between 1918 and 1947, calling for a boycott of British cloth and organising spinning centres and home cloth production all over India to strengthen village industries and the local economy. The movement played an important role in the Indian independence movement.

[43] Schumacher made the link between the application of technology in industry and its effects on labour and the well-being of workers. He argued for intermediate technology, that required more labour and less energy (fossil fuels) to produce the same amounts of goods, to avoid unemployment and impoverishment of workers, while simultaneously lowering environmental impact. He also argued for the decentralisation of production, stimulating local economies to lessen the gap between rich and poor, and also between high-income and low-income countries.

2000). He observed how aid programs attempting to implement the same pattern of industrialisation of Europe and the US in other contexts often did more harm than good. The large scale, energy intense industrial infrastructures didn't take into account the local natural and cultural environments (Pursell, 1993). The aid programs turned out to increase poverty, unequal distribution of wealth and environmental degradation.[44] In response, he founded the Intermediate Technology Development Group (ITDG) in 1965. By 'intermediate' Schumacher meant halfway in between indigenous and industrial technology. Intermediate technology would be designed with special consideration to the environmental, ethical, cultural, social, political, and economic aspects of the community it is intended for.

After criticisms of the term were uttered at a 1968 conference at the University of Oxford; some raised concern that Intermediate Technology would suggest inferior technology which would hinder acceptance and some thought the name implied a technological fix to development problems, ignoring social and political context; the term was changed to Appropriate Technology (AT). Since then, the AT movement gained momentum. Many AT institutions were created, both public and private, national, international and local. With its focus on renewable energy and frugal use of energy in general, AT became increasingly popular during the oil crisis (1973 – 1980), which in the US led to the founding of the National Center for Appropriate Technology (NCAT) by president Jimmy Carter and the Office of Appropriate Technology (OAT) by Governor Jerry Brown of California in 1976.[45] The movement, which was at first very institutional, turned into a two-headed program aimed at addressing both 'under-development' in the Global South and over-development in Europe and the US. The term was also picked up by different countercultural communities, such as the New Communalists and the network around the WEC, along with communities in the UK and Europe.

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[44] Large hydro-electric dams for example would cut off waterways needed by farmers for irrigation and a large part of the rural population would move into large cities in search of employment. Employment would often be poorly paid and under continuous pressure of further automation, leading to lay-offs.

[45] The movement was entangled with, and was given extra momentum by, the counterculture, also by the New Communalists circling the WEC, before Brand and Baldwin turned their back on AT in 1978. The Office of Appropriate Technology for instance, was housed in the Gregory Bateson Building, designed by architect Sym Van der Ryn, who was president of the Farallones Institute in 1974. The Farallones Institute and the New Alchemy Institute both promoted solar and wind energy, organic farming and the application of ecological values in the built environment.

There are many different definitions of AT and, for better and sometimes worse, even more interpretations and applications of those definitions (Pursell, 1993). In an OECD report, AT is described as "a wide range of technologies characterised by any one or several of the following characteristics: low investment cost per workplace, low capital investment per unit of output, organisational simplicity, high adaptability to a peculiar social and cultural environment, sparing use of natural resources, low cost of final product or high potential for employment" (Jequier and Blanc, 1983, p. 10).[46] In terms of actual technological objects, *Appropriate Technologies for Third World Development* describes AT as "small-scale but efficient, replicable in numerous units, readily operated, maintained and repaired, low-cost and accessible to low-income persons, compatible with local cultural and social environments." (Thormann in Akubue, 2000, p. 39).

From the start, the idea was suggested that in order to determine what exactly is appropriate in a given context requires decision making by the local community, yet this wasn't taken on board by all AT related organisations. In 1979 for example, during a congress of the International Federation of Automatic Control, chairman U. Pellegrini suggested that a technology should be considered appropriate only "when its introduction into a community creates a self-reinforcing process internal to the same community, which supports the growth of the local activities and the development of indigenous capabilities as decided by the community itself" (Pellegrini, 1980, p. 1). This sentence reveals an uneasy combination of systems theory with community self-determination. It resembles Buckminster Fuller's 'comprehensive anticipatory design science', the top-down model for change which requires an understanding of the whole first, to then work on the parts. Except there seems to be very little room for a local community to share *their* understanding of the whole. This top-down approach isn't surprising in the context of a conference of the International Federation of Automatic Control. Pellegrini proposes systems theory and control theory as the way forward:

> "we need not only the good will of 'homo faber' but, even more, that ability to manage complexity which is peculiar to the new man 'homo gubernator'."

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[46] The Organisation for Economic Co-operation and Development (OECD) is an intergovernmental organisation founded in 1961. Its aim is the stimulation of world trade. The majority of its members are high-income countries. In chapter 5 I discuss one of its daughter organisations, the International Energy Agency (IEA).

(Pellegrini, 1980, p. 5)

AT went from an anti-colonial drive for local autonomy and self-sufficiency to a neo-colonial one, something taken up by organisations in high-income countries looking to bring low-income nations into the global market economy. It was exactly this application of the term, that Brand and Baldwin called administrative and turned their backs on in *Soft-Tech* (Brand and Baldwin, 1978). To better understand (or problematise) this clash in interpretation of AT, I will briefly review its main characteristics when applied by government agency's and NGOs from the Global North, in low-income countries.

Appropriate Technology in the Global South

AT as it was rolled out in low-income nations such as India in the 1950s and 1960s didn't result in the Gandhian dream of self-sufficient village industries, because it was divorced from its necessary rejection of prioritizing urban, large-scale industry as proposed by Gandhi and Schumacher. In *The Poor Woman's Energy: Low-Modernist Solar Technologies and International Development*, historian of energy Elisabeth Chatterjee describes how energy dualism—large energy infrastructure for industry and cities combined with simple off-grid devices for the rural poor—led to the perception that such technologies could allow investment in the expansion of the electric grid to be avoided. This two-tier energy system led to a reinforcement of hierarchies of class, race and gender. Solar-cookers for instance, were perceived as cheap techno-fixes for the rural poor, who subsequently rejected them as second-rate. Because of the focus on the rural household, the imagined consumer-base of these technologies became gendered: solar became the 'poor woman's energy'. Experiments in the 1950s and 1960s failed, yet during the 1970s AT experts continued their quest of introducing devices such as solar cookers to the rural poor of the Global South, with the hopes that it would simply be a matter of developing a better device (Chatterjee, 2023).

Social transformation requires more than the right tool, as Chatterjee's analysis of AT in India powerfully demonstrates. In their essay *Appropriate Measures*, Jackie Brown and Philippe Mesly point to the same flaw in more general terms: AT didn't engage with the reasons why the Global South was struggling with poverty and the Global North was over-consuming, and instead aimed at fighting symptoms rather than the disease

(Brown and Mesly, 2021). Whether AT is introduced as techno-fix with a subsistence-centred view of the rural household, as Chatterjee described, or as transitional technology, aiming to eventually bring the rural poor into the fold of rapid industrialisation of the Global South, it ends up playing in favour of neocolonial relationships that enrich multinationals based in the Global North (Riddell *et al.*, 2024). From an environmental perspective, AT applied in low-income countries is solving the wrong problem. Wealthy nations over-produce, waste and pollute the most, so solving it by offering low-tech to nations with a much smaller environmental footprint doesn't make sense.[47] Brand and Baldwin's rejection of the term Appropriate Technology as it was applied in the Global South wasn't that articulate, but considering these arguments, it was a good idea. However, as I explained in the previous section, their initial, pre-*Soft-Tech*, use of the term wasn't at all about applying Gandhi's anti-colonial and Schumacher's degrowth-avant-la-lettre principles in the Global North. Were there other experiments that *did* inherit these ideas?

Appropriate Technology in the Global North

One year before Schumacher published *Small is Beautiful*, mathematician and economist Nicolas Georgescu-Roegen published *The Entropy Law and the Economic Process* in which he pointed out the relevance of thermo-dynamics to economics. He argued that the economic process irreversibly transforms natural resources into waste and pollution and that continuous growth means resources will at some point run out (Georgescu-Roegen, 1971).[48] His writing, together with Jaques Ellul's *The Technological Society* (1964), Lewis Mumford's *The Myth of the Machine: The Pentagon of Power* (1967), Roszak's *Where the Wasteland Ends: Politics and Transcendence in Postindustrial Society* (1973), and many other writings with radical critiques of industrial capitalism's devastating impact on the environment, inspired different European, Australian and US based grassroots experiments with AT. Where AT applied in the US domestically was mostly associated with the New Communalists, and governmental renewable energy projects, in Europe it led to a different set of practices. These also (partly) abandoned the term Appropriate Technology in order to distinguish themselves from the application of AT in the Global South. New terms emerged, all building on the ideas of Schumacher, complemented by Murray Bookchin's anarchist conception of technology's role in society: Alternative Technology, biotechnics and Radical Technology.[49]

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[47] I choose to focus on over-production of high-income countries, rather than over-consumption, because the focus on consumption can be misleading. It facilitates thinking about limiting consumption at the level of the individual consumer, rather than the driving force behind these patterns of consumption, the industrial capitalism of the Global North profiting from neocolonial power structures. When I say over-production, I mean production *initiated* in high-income countries, even though this is often outsourced to low-income countries, again to emphasise the origin of this over-production.

[48] Georgescu-Roegen became an important influence in the field of ecological economics and the degrowth movement. He briefly became a member of the Club of Rome but left them because of their lack of a strong anti-growth political stance and their growing fascination for ever more complex computer-based models (Levallois, 2010).

The most well known Alternative Technology initiative is the Centre for Alternative Technology (CAT), founded in 1973 in Powys, Wales. It became an eco-centre offering education and information about sustainable living, alternative technologies such as wind and solar power and organic farming. It was inspired by *Small is Beautiful* and *Limits to Growth* and aimed at offering ways to respond to the climate and biodiversity crisis. It still exists today, although it is struggling financially. CAT was initiated and funded by business man Gerard Morgan-Grenville, great-grandson of the last Duke of Buckingham and Chandos, who used his network to supply the centre with funds and resources. One of the early visitors were the Duke of Edinburgh and the Prince of Wales. CAT generated a lot of attention and momentum for environmentalism in the UK, yet I will discuss another project, the Biotechnic Research and Development (BRAD), in more detail because it started without patron, aiming to test the validity of ideas and technologies within a social context relying on nothing but themselves.

The anti-capitalist BRAD was founded by Janine and Robin Clarke in 1973, the same Clarke(s) who had introduced a larger audience to the term soft technology in the 1972 *Undercurrents* article.[50] They proposed something quite opposite to ephemeralisation and ecomodernism and did inherit some of Gandhi's ideas. Rather than highly concentrated urban centres separated from their surrounding natural environment by technology, they proposed:

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[49] Alternative Technology was first used by Andrew McKillop and Peter Harper as the name for a conference at the Bartlett School of Architecture, University College London, in 1971 (Harper and Boyle, 2012). It resonated with a lot of people, according to Harper (2012) because it suggests that "for any given sociotechnical problem there was a new approach that would resolve it", and coincidentally became the name of a movement. It was first used in a publication by Peter Harper in *Undercurrents* magazine in 1972, as Appropriate Technology applied to a "developed situation" (MacGregor, 2013). Radical Technology was the title of a 1976 book edited by Harper and Boyle.

[50] The 'Biotechnic' in BRAD was directly borrowed from Lewis Mumford as the opposite of technocratic, a science and technology in support of human life and all that supports it, rather than the state, the military and capitalism. They dropped the word soft technology in favour of it.

> "the alternative is based on a combination of decentralist politics coupled with a novel and decentralist technology. It leads to a type of society whose base is essentially rural rather than urban and whose environmental problems are solved by what is the only possible route: by re-integrating men with the natural systems on which they depend." (Clarke and Clarke, 1972, p. 168)

BRAD focused on decentralised politics and technologies that were only possible on a small and decentralised scale, guided by the motto "technology should be valid for all men for all time" (Clarke and Clarke, 1972, p. 169). To them this motto indicated clear limits. Applying it would exclude technology relying on the manipulation of one group by another, technology which if deployed globally would have negative cumulative effects on people and the environment, and all technology relying on the use of resources that will subsequently not be available to future generations. Clarke and Clarke envisioned the research community to develop their program in three stages: they would start with conventional biotechnic research; then the research community would mix research with early efforts to formulate and practise a new way of life; and finally the community's practice would achieve long-term ecological stability. The last stage would only be possible after technical and social problems had been solved, making BRAD's experimental practice an example of prefigurative politics.

Clarke and Clarke (1972) were very aware of the failures of Appropriate Technology as it was introduced in low-income nations, where it was perceived as another way to delay development. They wanted to develop Appropriate Technology to test and demonstrate that it was a preferred technology to high-tech by some in the privileged parts of the world too. Their focus on a centre stemmed from the idea that AT is not about isolated technologies but about developing technologies within a social context in which all implications of it can be tried and tested simultaneously. Their concept of a biotechnic community was inspired by Murray Bookchin's *Liberatory Technology*, emphasizing how the social, political and ethical implications would go far beyond mere technological practice.[51] They wanted to develop and demonstrate a 'third way', between over- and underdevelopment, clearly inspired by Gandhi and Schumacher's thinking. Their project also explored alternative methods of knowledge production, another way of practising science by combining scientific research, craft, tacit knowledge and folklore. Theory and practice would go hand in hand, and science would be moved from the lab to the communal home.

Before setting up the centre they were already fully aware of the obstacles, noting that most communities exploring alternative lifestyles are "either parasitic on industrial society or fail because they refuse to be so." (Clarke and Clarke, 1972, p. 171) The group that gathered at the farm in Wales brought with them a lot of theoretical knowledge and very little hands on skill, yet they successfully set up the farm and managed to stay afloat financially. Still, in 1975, after only 18 months, Clarke and Clarke (1976) left Eithin-y-Gaer. indicating a failure to make a community as the reason for their departure. However, it seemed to have fallen victim to one of the obstacles they had identified in 1972. They might have failed because they refused to be 'parasitic on industrial society'. Energy and technology scholar Anthony Akubue notes that it is important to acknowledge that technological progress is a political process which reinforces the interests of a dominant class and argues that changing this requires policy action to remove incentives in favour of capital-intensive technology (Akubue, 2000). Without a wealthy benefactor or policy action, prefigurative politics are like swimming against the stream, and those attempting it are at risk of burning out.

Both terms, biotechnic and Alternative Technology, were supposed to indicate a departure from business as usual, from a growth based economy and wealth at great cost to the environment and low-income countries. Yet the prefigurative politics concerning social organisation and the role of science and technology in society were quickly lost. Only some of the ideas tested at both farms have become mainstream; the ones that were easy to adopt widely because they were perfectly compatible with business as usual. Recycling and renewable energy don't overhaul the economic system, or the political one that upholds it. BRAD and the editors of *Undercurrents* were concerned with community organisation, ecofeminism and citizen science and were inspired by anarchist politics and Buddhist economics, yet "the semantic pull of the word 'technology' in its everyday sense tended to restrict the use of AT to hardware, and more specifically energy." (Harper and Boyle, 2012). Yet even though BRAD and related experiments failed at overthrowing 'the system', they created a much needed space for resisting capture. They opened up to possibilities and cultivated a willingness to think against the spell of progress. How did they challenge capitalist sorcery and what were their pitfalls, in other words, how can this kind of anti-capitalist struggle be protected from that which threatens it?

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[51] For a description of liberatory technology, please see the *Damaged Earth Catalog* excerpt in the portfolio.

Appropriate Technology's redefinitions of technology

Since Appropriate Technology was a term used for many different practices, it is impossible to formulate overarching challenges to dominant Western definitions of technology. Gandhi's ideas, adopted in part by Schumacher, were clear challenges to the idea that technology, naturally and necessarily, evolves from small scale, decentralised village industries to centralised large scale urban industrialism. The idea that technology should serve the majority of people, rather then put them out of work, and that strong village industries would strengthen local economies and make them less dependent on (neo)colonial powers was a clear and profound challenge to the word 'technology' as understood in the Global North, then and now. These ideas found their way to grassroots initiatives experimenting with AT in the US and Europe, which each chose their own word to describe their practice. In the US Appropriate Technology at the grassroots level, was associated with the WEC and its readers, the New Communalists, which later chose to distance themselves from the term in favour of soft technology. In the UK, communities experimenting with AT also distanced themselves from the term in the early 1970s and chose Alternative Technology and biotechnics instead. What traces did the ideas at the origin of AT, those of Gandhi, and subsequently Schumacher, leave in the grassroots practice of AT in Europe and the US?

In 1986, 8 years after *Soft-Tech* was published, political scientist Langdon Winner, published a critique of the Appropriate Technology movement. It is interesting to note that Brand and Baldwin's attempt to dissociate from AT failed, because Winner still strongly associates AT with the WEC. He unfortunately doesn't make any distinction between soft technology, Alternative Technology and biotechnics, missing the sometimes subtle but fundamental differences between these. His observations sell the UK practices short. As opposed to soft technology, Alternative Technology and biotechnics did pose a challenge to dominant interpretations of technology, most notably through their commitment to degrowth: doing 'less with less', in stark contrast with soft technology's 'doing more and more with less and less'. They challenged the dominant idea about the role of technology as allowing for unlimited economic growth without damaging the environment. Instead, it offered a view of technology at the service of biodiversity and limited resource use, proposing a softer, smaller and more modest view embedded in social practices inspired by Gandhi, Schumacher, Kropotkin and Bookchin.

Even though Winner's analysis generalises and applies mostly to soft technology, he observed two shortcomings which are important to consider when thinking about protecting anti-capitalist struggle from capture. First, he identified the failure of AT in the US to challenge dominant cultural norms, which he deemed problematic since it is exactly these ideas about technology that have proven to be a problem (Winner, 1986).[52] He observed how the turn to technology as target for social justice struggles in the late 1960s coincided with a general disillusionment with politics which drained the energy from protest movements. Winner observed that many turned to a type of socio-technical tinkering with solar power, windmills and rooftop gardens as forms of community action. He pointed to the WEC as evidence of this transition. Rather than a large diversity of political activisms, it promoted 'good technology'.

> "If you were moving back to the country and needed a good sturdy cider press, The Whole Earth Catalog would tell you where to purchase one." (Winner, 1986, p. 66)

In the WEC inspired Appropriate Technology experiments, he sees an example of 'the better mousetrap' theory: as long as your product is better it will become successful, and if enough people choose the ‘right’ tool, this will shape the future. He argues:

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[52] He reasoned that earlier attempts at challenging these norms, for instance by nineteenth century utopians such as William Morris or anarchists like Peter Kropotkin, haven't left a lasting legacy for others to build on. Winner doesn't acknowledge how Kropotkin's ideas on decentralised village industries greatly inspired Gandhi, who was an avid reader of Kropotkin (and Tolstoy) (Woodcock, 1967, p. 234; Jha, 2015). Kropotkin's contribution to anti-colonial struggle is worth considering as lasting legacy. Kropotkin's indirect influence on Schumacher even brings this legacy to the US.

> “People would, in effect, vote on the shape of the future through their consumer/builder choices.” (Winner, 1986, p. 79).

Consumer activism, the choice for the right technologies, old or new, was the model for change, not the right politics. To Winner this explains the many catalogs, fairs, DIY manuals and information sharing happening around Appropriate Technology. Even though he generalises about, and dismisses the prefigurative politics happening within Alternative Technology and biotechnics communities, this observation points to an overarching missing element in AT’s successors: none of the communities developed strategies to confront the social and political forces that might work against them, they were defenceless against capitalist sorcery’s capture. Even though I agree with Winner’s observation, it is equally important to note that his generalisations loosen the hold of AT’s diverse experiments and ‘trajectories of apprenticeship’. He dismisses a diverse set of local and situated practices that confront capture locally and to which generalisation is a poison “because it risks loosening that hold, proposing a shortcut that would stop the process of learning.” (Pignarre and Stengers, 2010, p. 76) This is why paying attention to differences is messy but necessary.

Winner’s second and related observation applies to soft technology, Alternative Technology and biotechnics: they all lacked knowledge regarding why certain technologies came to be the way they are; they lacked an understanding of why some technologies became dominant and others disappeared. Technology’s role in industrial capitalist economies requires confronting how it affects labour and reinforces existing power structures. As Turner (2006) argues for example, soft technology’s technologically assisted lifestyles helped bring about the acceptance and normalisation of post-Fordist modes of production in which workers can no longer count on permanent contracts and social security. As briefly discussed in chapter 1, Whittaker describes how the roots of modern computing are in efforts of worker control—through the automation and disciplining of labour, inspired by technologies of control developed on plantations—not in dreams of empowering decentralised communities (Whittaker, 2023). Malm, in *Fossil Capital*, demonstrates how the switch from renewable to fossil energy was not based on a comparison of prices or ‘ease of use’, it gave industrialists more control over their workers.

Such insights are essential when thinking through how grassroots practices can challenge dominant technical practices, and would lead to the conclusion that modelling change is not enough as a model for change.

Conclusion

The end of the Appropriate Technology movement has been dated quite precisely by Winner (1986): Tuesday November 4, 1980, the day Ronald Reagan was elected president of the United States. I consider this the day ephemeralisation, Buckminster Fuller's (1938, p. 259) term for the process of technological development allowing to do more and more with less and less, won over that of degrowth.[53] To illustrate, I want to share an excerpt from a speech by Reagan to students and faculty at Moscow State University, in the Soviet Union, 1988:

> "Standing here before a mural of your revolution, I want to talk about a very different revolution that is taking place right now, quietly sweeping the globe without bloodshed or conflict. Its effects are peaceful, but they will fundamentally alter our world, shatter old assumptions, and reshape our lives. It's easy to underestimate because it's not accompanied by banners or fanfare. It's been called the technological or information revolution, and as its emblem, one might take the tiny silicon chip, no bigger than a fingerprint." (Reagan, 1988)

After Reagan's election, the politicians promoting and supporting AT projects left government offices and funding dried up. Appropriate Technology no longer matched the ambitions of the US government. Reagan elaborates on his technology-enabled neoliberal revolution:

> "In the new economy, human invention increasingly makes physical resources obsolete. We're breaking through the material conditions of existence to a world where man creates his own destiny. Even as we explore the most advanced reaches of science, we're returning to the

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[53] The word ephemeralisation was never popularised, it got replaced by dematerialisation, decoupling and more generally by efficiency, which I'll discuss in chapter 5.

> age-old wisdom of our culture, a wisdom contained in the book of Genesis in the Bible: In the beginning was the spirit, and it was from this spirit that the material abundance of creation issued forth." (Reagan, 1988)

The role of technology in society as alchemical, popularised by the WEC and CQ, made it to a speech of the president of the United States who compared it to God's creation of everything out of nothing. With all hope for AT to bring about more modest and sustainable living within the US and EU and rural emancipation in low-income nations gone, the cybernetics-inspired rift between information and matter promoted by the *WEC*, *CQ* and *Soft-Tech* became not only mainstream but the driving force behind neoliberal policies such as networked forms of production, temporary contract based employment, global outsourcing and deregulated marketplaces (Turner, 2006).[54] Winner's suggestion that AT should have focused on why some technologies became dominant and others disappeared was apt. Certain interpretations of AT challenged the foundations of industrial capitalism. It threatened existing neocolonial power structures which rely on centralised large-scale industrialism in the Global South.

Instead, Appropriate Technology offered a view on technology at the service of degrowth, antithetical to the US 1980s campaign to 'remasculinise' America. Historian Carroll Pursell sees the defeat in Vietnam as a trigger for this. AT's 'soft' and 'small' technology and philosophy of 'enoughness' represented a direct, feminine, threat to hegemonic notions of technology as masculine (Pursell, 1993). These subversions of the dominant ideas about technology are an important legacy of AT. As Raymond Williams argued in *Keywords*, the meaning of words is often contested, it changes over time and through cultural shifts (Williams, 1976). The challenge AT posed to the definition of the word 'technology' happened through an expansion of it, ripping it from the specialist field of engineering and bringing it into the realm of citizen science and the (communal) home. It also expanded its definition to include larger social systems rather than a narrow focus on tools (Pursell, 1993).

The battle over the 'true' definition of technology and the disappearance of terms contesting dominant views means the stakes were (and still are) high and it was valuable to revisit one that has not stood the test of time. This is one of the terms that challenged not only definitions, but the power of those with vested interest in the continuing growth of technological systems supporting their power. Pursell describes the profound cultural shock AT represented in 1980s America:

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[54] For an in-depth discussion of the relationship between the network around the WEC and its role in normalising postindustrial forms of production and culture, linking both to the interdisciplinary work style of the WWII military-industrial-academic complex from which cybernetic theory originated, please see the work of Turner (2006).

> "Reagan and Rambo were the perfect representatives of a masculine backlash against all of these, including what could be characterized by them as a cowardly and self-indulgent refusal to embrace technological vanguardism as the finest expression of national virility" (Pursell, 1993, p. 636)

Soft technology, Alternative Technology, biotechnic and Appropriate Technology were often used interchangeably. All of the terms were interpreted differently in different contexts, yet some key differences became clear during the decades that followed their disappearance. A split happened between Alternative and Appropriate Technology's anti-urban 'techno-peasants' and the ecomodernist tendencies of the WEC and CQ's soft technology, which promoted a new elite which reflected a masculine, entrepreneurial, educated, white world centering on the individual to model social change. It turned away from questions of gender, race and class in favour of a rhetoric of individual empowerment (Turner, 2006; Ensmenger, 2015; Rankin, 2018).

Even though the ideals reflected in the pages of *Radical Software* and the experiments of the Appropriate Technology movement have not been realised, this doesn't mean they should be abandoned. To revisit Roszak, despite their shortcomings, these were strong attempts to break the spell of capitalist sorcery working to "denature the imagination by appropriating to itself the whole meaning of Reason, Reality, Progress, and Knowledge", making it "impossible to give a name to unfulfilled potentialities but that of madness" (Roszak, 1969, p. xiii). Those two decades were the first since the industrial revolution in which a radical redefining of technology took place. New words to reflect this were invented. Unfortunately, this was overshadowed and snuffed out by the tech utopian views promoted in the WEC and CQ. Buckminster Fuller's concept of ephemeralisation made it from the pages of his 1938 thought adventure to the lips of a US president; and became the decoupling myth I discussed in chapter 1, reframing Western industrial capitalism from the cause of, to the only escape from, environmental collapse.

Sixty years later some of the challenges posed to the dominant definition of technology are reappearing under different names. When comparing the context of the experiments of today with those of more than half a century ago, the similarities are inescapable. The increasingly dire warnings of environmental collapse, the unbearable injustices of the wars being waged, coupled with the alienation resulting from a still very rapid development of industrial technology remain, as does an increasing disillusion with electoral and institutional politics. There are equally inescapable differences however. Young people in the US and Europe are growing up in increasingly precarious conditions and many cannot afford to 'drop out'. Access to participation in society and social tolerance for diversity achieved by the civil rights, feminist, LGBTQI+ movements and the counterculture are being threatened by a rise in right wing extremism as well as by the right-wing libertarianism that resulted from the 'Californian ideology' promoted by Brand (Barbrook and Cameron, 1995; Mancini and Palazzo, 2021; Sanders and Jenkins, 2022). Geopolitical powers have shifted and power over chip factories, military technology and technological infrastructure drives governments to shield the tech industry from regulations, fearing that might make them move their headquarters to another country, or hinder their financial growth and subsequent investments in innovation (Donnelly, 2023; Bradford, 2024). Despite the bleakness of the situation, there is a revival of small scale technical practices aiming at doing (network) technology otherwise, bringing it into relation with environmentalism. In the next chapter I'll discuss a contemporary project of redefinition in the context of art and cultural production: permacomputing.

Chapter 3

Permacomputing

At the beginning of this research project, I decided I wasn't going to commit myself to one term. Not in my choice of words, not as the focus of this research project and also not in my own practice. I wanted to learn what this diversity of practices has to offer in terms of a redefinition of technology. I wanted to show this diversity as a strength rather than a weakness. I was inspired by the concept of the pluriverse, which informed this project's emphasis on diversity, its valuing of the reimagining and reconstructing of local worlds in which technology serves situated and specific needs rather than dictating universal 'solutions'. Despite this commitment, I ended up personally entangled with the development of the term permacomputing, through a collaborative process of learning with others. I ended up co-writing a text with Ville-Matias Heikkilä, who coined the term in 2020; I presented permacomputing to different audiences and I took part in discussions with the community gathered around the permacomputing wiki. My longtime collaborator and partner Aymeric Mansoux worked on a post-doc focusing on applying permacomputational principles in higher education in the arts, making it an ongoing discussion in our household.[1] *When faced with the question of which term I should pay closer attention to, I chose the one I was closest to. This chapter therefore became a blend of observation—critically situating the ideas around the term historically—and participation—adding my own thoughts to the ongoing conversation*

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[1] The permacomputing wiki was set up by Mansoux and Heikkilä in 2022 and is open to a small group of editors. I am grateful for and indebted to the many discussions with people from this group. The community around the permacomputing wiki includes: Delisa Fuller, Luke Murphy, Danny Tirthdas van der Kleij, Brendan Howell, Aymeric Mansoux, Manetta Berends, Ola Bonatti, Michal Klodner, Ville-Matias Heikkilä, Nancy Mauro-Flude, Lukas Engelhardt, Pixel, anna andrejew and Marinus Savoritias.

of what permacomputing could be. It has been a process of learning through dialogue, embracing potentials and identifying blind spots. The result of this process is an in depth description of permacomputing, unpacking one of the counter-narratives practised today, within a historical context.

Introduction

In this chapter I will explore the practice and ideas around permacomputing, a relatively new term and small community thinking through ways to diminish tech's negative environmental impact. I will look into what it inherited from the past and which new contributions it proposes to a redefinition of tech in this time of climate crisis.

In the first section I describe the origin of the word permacomputing. It's a short history of the very recent past, which serves to document how this term spread. The chapter gives an idea of the places and contexts in which the term circulates, besides, after having reverse-engineered the path of Appropriate Technology and having encountered the slightly revisionist recounting of soft technology's origins in *Soft-Tech*, I realised it is valuable to document its development at this stage in its short life. In the second section I cover some key characteristics of permacomputing as it is practised today. I discuss these through two examples: the projects *Uxn* and *What Remains*. In the second section I review two key concepts that are hard to discuss in terms of concrete outcomes: careful observation and 'not doing'.

In the third section I look into which elements permacomputing inherited from past practices. It takes inspiration from permaculture and copied its use of abstract design principles and its lack of strategic politics, which for permaculture have become a problem of accessibility and lack of larger scale transformative impact. In the final section I discuss if and how permacomputing challenges dominant definitions of technology. Permacomputing reverses the pivot performed by soft technology, by reasserting tech as part of the problem of environmental degradation, a rematerialisation rather than ephemeralisation. Next to that, it starts to make space for issues of race, gender and class. The creative repurposing of discarded tech and the rejection of cloud computing services has the potential to give communities choice and agency over how they want technology to feature in their lives, while challenging capitalist sorcery's sorting spell.

Permacomputing origins

> "This is a collection of random thoughts regarding the application of permacultural ideas to the computer world." (Heikkilä, 2020)

The origin of the term permacomputing is a blog post from June 2020 by Heikkilä, a demoscene coder, graphician and musician going by the moniker viznut.[2] In this post, he describes what he considers a meaningful and sustainable role for computing within a human civilisation that has a meaningful and sustainable place in the planetary biosphere. He takes inspiration from permaculture, a term coined in 1978 to describe an approach to agriculture and land management that aims at benefiting the natural environment, in opposition to industrial agriculture which depletes soils, pollutes waterways and harms biodiversity. Heikkilä describes the parallels between the problems caused by industrial agriculture and the ones caused by technological monoculture. He explains how methods proposed by permaculture practitioners could also be applied to computing, methods that 'let nature do the work' and rely on the minimal use of artificial energy. The main appeal to him is that permaculture doesn't propose going back in time but instead focuses on human ingenuity: "clever hacks for turning problems into solutions, competition into co-operation, waste into resources." (Heikkilä, 2020) He sees this creative thinking as akin to the inventiveness he appreciates in computer hacking.

Heikkilä's blogpost was shared on Hackernews in June 2020 and on the fediverse in August that same year. Some started adopting the term to describe a project. One of the early adopters was a British programmer going by the handle Öppen, who used the term to describe his Gemini browser called Ariane[3] (discontinued). Czech artist and programmer Michal Klodner started using the term permacomputing to describe his work at the Node9 Livinglab in a forest in the Bohemian Karst in Czechia, a project exploring off-grid architecture, solar energy and artistic research. I included a description of permacomputing, based on Heikkilä's blogpost, in the paper *A pluriverse of local worlds: A review of Computing within Limits related terminology and practices*, published in June (2021a). I presented the paper at the annual Computing Within Limits workshop that same month. The adoption of the term by musician and designer Devine Lu Linvega, who wrote about it on their wiki in July 2021 was influential. They have a wide following as founder of the Merveilles community on the fediverse and are drawing media attention through their artistic work as part of the collective *Hundred Rabbits* but also through their lifestyle: living on a boat, having to adapt to the lack of network connectivity and availability of electricity while travelling. After this increase in visibility, Heikkilä published an update to his original permacomputing text in August 2021, stating he was unaware of people having similar ideas and now wanted to connect his ideas with existing discussions and activities.[4]

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[2] The demoscene is a computer art subculture whose members create demos, computer programs that demonstrate the creator's skills in programming, computer graphics and music. The demoscene is known for squeezing the most out of very restricted computing resources, such as the 4k intro with a maximum executable file size of 4096 bytes.

[3] Gemini is an internet protocol used for accessing remote files, not unlike Hypertext Transfer Protocol (http) and gopher. It was developed in 2020 by a programmer going by the name of Solderpunk.

Since then, more events and projects have become associated with the term. Dutch audiovisual art festival FIBER's *Reassemble Lab: Natural Intelligence*, curated by Katia Truijen, took place at *A Lab* in Amsterdam (10 – 13 March 2022). Here I presented my research on permacomputing among other terms (10-03-2022), and artist and researcher Aymeric Mansoux hosted a workshop on permacomputing (12-03-2022). This event gathered a diverse group of artists and researchers interested in exploring what permacomputing could be as practice in the field of art and design. In April 2022 Mansoux started working on a postdoc researching how permacomputing could be applied in the context of higher education in the arts at Willem de Kooning Academy, Rotterdam. Iffybooks in Philadelphia started organising monthly permacomputing meetups that same month.[5] In May the permacomputing mailing list was started by Heikkilä and Mansoux. In June 2022 the permacomputing wiki and IRC channel were started, followed by an editathon, on August 20, at Varia in Rotterdam as part of Mansoux's postdoc.[6]

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[4] Heikkilä expanded on certain elements of his first text, clarifying his position on 'low complexity' and adding a section on 'concrete examples', envisioning what a 'permacomputer' might look like. Heikkilä also incorporated elements from my paper and added terms that came up in two polls on Mastodon (Calcifer, 2020; de Valk, 2021c).

[5] Iffybooks is a bookshop and workshop space focused on hacking, free culture, gardening, and zines.

[6] The permacomputing wiki includes texts about what permacomputing is, how to get involved, examples of projects, related texts and more. The wiki is edited by a small group that self-organises via a closed XMPP channel (chatroom). There is also a moderated open XMPP channel where anyone interested in permacomputing can join and discuss related topics.

In December that year Heikkilä and I published a short text on permacomputing for a publication called *Counter-N*, commissioned by media theorist Shintaro Miyazaki from Humboldt-Universität zu Berlin (de Valk and Heikkilä, 2022).[7] More chat channels and forums appeared. Artists, programmers and researchers Ola Bonatti, Brendan Howell, Luke Murphy and Lukas Engelhardt gave several permacomputing workshops and talks at various events.[8] In June 2023 the paper *Permacomputing Aesthetics: Potential and Limits of Constraints in Computational Art, Design and Culture* was published in the context of the *Computing Within Limits* workshop (Mansoux *et al.*, 2023). Howell started hosting monthly permacomputing meetups in Berlin. In May 2024 the article *Permacomputing: la discrète communauté qui défend des outils numériques libres, sobres et décroissants* was published in *Le Monde*, including excerpts from an interview with Mansoux and myself (Hadjadji, 2024). The term has been picked up and is increasingly circulating.

Main characteristics of permacomputing

What are the main characteristics and key concepts of permacomputing as it is practised and written about by practitioners? At the moment of writing, permacomputing is adopted mostly by artists and designers from North America, Europe and Australia, and I will discuss it as a practice situated within that context.[9] It is impossible to provide a 'dictionary definition' because the term is new and its meaning (even within the narrow context in which it is used), is under negotiation. There are continuous discussions about what it is and what it could be. These discussions take place at events, in chatrooms, forums and on the fediverse. Because of this, I will not try to provide a single definition, but rather highlight some key ideas that are relevant in the context of redefinitions of technology. I'm basing my observations on these discussions, Heikkilä's blogposts, the permacomputing wiki, the text *Permacomputing* written by myself and Heikkilä and the paper *Permacomputing Aesthetics: Potential and Limits of Constraints in Computational Art, Design and Culture*, written by Mansoux, Heikkilä, Howell and Barok (2022; 2023). It is my interpretation of the term based on my involvement in and exchanges with people actively using the term to describe their work, and as is clear from the sometimes heated debates in chatrooms and on the fediverse, it is not shared by everyone participating in discussions about it. [10]

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[7] The text was based on four questions by Miyazaki and was structured as a conversation between the three of us. The questions focussed on differences between practices, which led me to connect some feminist principles to permacomputing to emphasise similarities and create bridges. This resulted in us discussing three points from *A Feminist Server Manifesto*, an interesting stretching and connecting of the term to other practices (Reiter *et al.*, 2014)

[8] This is not an exhaustive list. Here I highlight a few to show the slow but sure spread of the use of this term since it's first appearance online.

[9] The term is picked up by people within a diversity of contexts, but the most active and visible projects are, at the time of writing, in the cultural field. These include contexts such as indie game development, the demoscene, independent publishing, media and performance art; with projects ranging from software for organising to artistic output.

The first characteristic of permacomputing I'd like to highlight is that it aims for a polyculture.[11] Just as permaculture resists the soil depleting and biodiversity killing monocultures of industrial agriculture, so permacomputing resists the technological monoculture offered by Big Tech. Not only because Big Tech depletes physical resources and energy through its global scale and unrelenting push for growth. Permacomputing also resists Big Tech because Big Tech impoverishes computing culture and dismisses cultural difference by proposing one-size-fits-all services and tools. Permacomputing embraces diversity as enriching and mutually supportive rather than something to be out-competed. The permacomputing design principles do point out that standards have their place. They are there to "facilitate co-existence and co-operation of different pieces of technology, not to limit their diversity. So, they are more like common languages than norms." (Permacomputing wiki, 2022)

Unix-style interoperability of small programs is an example of how standards can promote diversity. A large number of small applications go hand in hand with the shared underlying system of 'everything is a file' interoperability and modularity. This is not to say Unix-style operating systems are examples of permacomputing, this is simply an example of how a certain standardisation promotes diversity. This allows for a modular approach to solving problems by combining multiple small programs. However, modularity is by no means a neutral method promoting diversity, as can be learned from media studies scholar Tara McPherson's work on modularity and race. McPherson (2012) applies a cultural and technical lens in her analysis of how the development of UNIX style modularity and its organisation of information and capital was in many ways a response to the social struggles for racial justice and democracy in the 1960s US. She argues that this turn to modularity coincided with encapsulation and partitioning within political organising, moving away from more radical forms of alliance-based political practice (Mcpherson, 2012). A computational polyculture with attention to global and overarching struggles, allows for diverse ways of computing embedded and attuned to the context while allowing for alliances and mutual support: situated technology rather than a false universality which perpetuates very specific, compartmentalising ways of working and organising stemming from a North-American, military-industrial world-view.[12]

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[10] The term is also picked up by people who have a radically different interpretation of it, which is perceived as problematic by other practitioners, such as when it is applied to energy and resource intense technologies such as VR or AI. As stated in the introduction, the goal of this research project is to describe the potential of practices, rather than defend them as if they were weak. The scope is therefore 'what works and how' in relation to redefinitions of technology, rather than critique and disagreement.

[11] I prefer the word pluriverse for its decolonial origin, but I'm using the terminology of the permacomputing wiki in its current form to stay closer to the way the practice is communicated at this moment.

In all of its diversity, permacomputing holds to some key values. It is a computing practice which resists maximalist techno-aesthetics. It is a practice that tries to do better in terms of energy and resource use, yet does not give up on computing altogether (Mansoux *et al.*, 2023). Maximalist techno-aesthetics, a term coined by Mansoux et al., is an aesthetics that values the highest fidelity technically attainable, a pleasure taken in providing the closest reproduction of reality possible, no matter the costs (to people or the environment) or function (perceivable with the senses or not) and which is intimately linked to the stimulation of continuing consumption of new products and the maximisation of shareholder value by industry. It is based on the premise that 'more is more' and that an increase in information is always better, resulting in ever higher resolutions in digital imagery, ever higher bit rates in streaming video, ever higher fidelity in digital sound.[13] These aesthetics result in an increase in resource consumption by creating demand for newer devices such as screens, smart phones, computers and servers, an increase in electricity consumption of those devices and upgrades in network infrastructure such as more data centres at the edge of networks, 5G and fiber-optic networks

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[12] For an in depth discussion on the harms of standards and universality to marginalised groups in technological infrastructures, please see *Power, Technology and the Phenomenology of Conventions: On being Allergic to Onions* (Star, 1990).

[13] Maximalist techno-aesthetics is a combination of maximalist aesthetics, as used by Heikkilä in *Maximalism and Virtualism* and Gilbert Simondon's techno-aesthetics as used in his unsent letter to Jacques Derrida, dated July 3rd 1982 (Simondon, 2012; Heikkilä, 2021a). Because the 'more is more' of maximalism can refer to so many different fields, from literature to design, the writers combined it with Simondon's term to focus it on technology. Techno-aesthetics refers to how something can be "aesthetic because it's technical, and technical because it's aesthetic." (Simondon, 2012, p. 2) It expresses the pleasure of experiencing something that shows its technical nature, origin or inner-workings for its own sake.

(Mansoux *et al.*, 2023). How does permacomputing propose putting this resistance into practice?

Collective learning, design for energy descent, waste as resource and planned longevity

Permacomputing rejects maximalist techno-aesthetics through a collective process of learning and exchange about how enough can be done with a lot less, embracing self-imposed limits as a method to think more creatively about what needs doing and how it could be done. It is a practice, a hands-on testing of ideas and experimenting with what degrowth could look like in computing. It doesn't relate to one particular kind of technology but instead tries to offer a way to evaluate whether technology is needed in the first place and if so, how to make sure this technology uses as few resources and energy, and leaves as little waste, as possible. This means it doesn't attach itself to specific hardware, software, programming languages or operating systems, although it is applied to them. Because it aims at a collective process of learning, it promotes the use of Free Libre Open Source (FLOSS) licenses for software, with a critical awareness of their flaws.[14] The permacomputing wiki introduces people to methods of how to achieve this through the use of design principles. Rather than presenting those quite abstract descriptions that are, at the time of writing, divorced from practice, I will discuss a few key strategies I observe as they are practised and discussed in the community.

The first strategy, which supports doing enough with less, is to design for energy descent, a frugal use of energy by hardware, making sure software remains lean and free of bloat, as well as an overall reduction of computer and network infrastructure use. In other words, it is not about being more efficient, it is a different way of thinking about the role of computing in specific contexts. Both permaculture and permacomputing aim at degrowth in terms of energy use by trying to work on lifecycles that need as little externally added and artificial energy as possible, and by working with what is already there. In permaculture this means using compost rather than industrial fertiliser, using sunlight rather than lamps and gathering and holding onto water locally rather than irrigation from external and artificial sources. It also means producing less. The same closed cycles are not possible in computing, but there is a lot of room for improvement in terms of energy use, such as making computing compatible with the fluctuating supply of renewable energy, as opposed to making energy infrastructure compatible with the demands of (cloud) computing. This way computing becomes less dependent on fossil fuels. Heikkilä (2020) describes how adapting to available energy and using it 'wisely' would help counter the wasteful practices of computers and servers needing to be 'always on' and always ready to perform at maximum capacity.[15] When there is low availability of energy, background processes could pause; and user interfaces could become more rudimentary; clock frequencies could decrease; unneeded processors and memory banks could power off (Heikkilä, 2020).[16] Software source code could be maintained, optimised and occasionally refactored to remain free of bloat. Designing for energy descent means that next to accommodating energy supply fluctuations, it should also allow for network intermittency, meaning offline-first design but most of all it means asking if computing is needed in the first place.[17]

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[14] The permacomputing wiki makes a point of how the universally applied openness of most early licenses opened FLOSS licensed works up to exploitation by the software industry, rather than creating a commons in the public interest (permacomputing wiki, 2023).

A second and third strategy are working with waste as a resource and planned longevity, inspired by permaculture's use of perennials over annual crops to avoid tilling, overcultivation and soil depletion and composting and mulching to create self-sustaining cycles. Permacomputing translates these principles into aiming for planned longevity as opposed to planned obsolescence, with a focus on working with what is already there through repair and maintenance of hardware and code, overlapping with repair culture and salvage computing.[18] Computer hardware represents an incredible amount of embodied energy[19] and resources such as rare earth minerals, aluminium, copper, glass, tin, lithium, zinc, and plastic and conflict minerals such as tantalum, tin, tungsten and gold. Most importantly they contain microchips produced in so-called fabs using vast amounts of electricity and water and producing hazardous waste (Gupta *et al.*, 2021). PCs and mobile devices use more energy at time of production than during their use-phase, making it well worth using these devices as long as possible (Pickstone, 2021). Implementing this means that hardware needs to be designed for disassembly, so that if a component breaks, it can be repaired or replaced.[20] For this to be realised on a larger scale, permacomputing needs to create public pressure on policy makers and industry, which is currently not an active part of the practice. What is practised however is creating new software projects for older devices and reusing old components to create 'new' hardware projects. I will discuss two examples of this in the following section.

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[15] With 'wise use', Heikkilä means scheduling only the urgent and essential computing to take place at times of low energy availability and leaving the heavy and/or non-urgent tasks for times of surplus.

[16] Some of these measures could also be taken in times of low demand.

[17] Off-line first design means designing software that functions without network connectivity first. It can include network functionality, but doesn't rely on it. This used to be the default, but since cloud computing and Software-as-a-Service this is no longer the case.

[18] Salvage computing is computing which makes use of the millions of devices which already exist but which are discarded through the rapid upgrade-or-die cycle of the tech industry and consumer capitalism. Repair culture, with its very long history, is the umbrella term for repair practices in all its cultural diversity.

[19] Embodied energy is the energy required to produce a product, including the energy used in mining the raw materials, transport, manufacture and assembly. It is a useful concept when trying to determine the total energy consumption during a product's entire life-cycle.

Two permacomputing projects: Uxn and What Remains

In practice, this collective learning to design for energy descent, working with waste as a resource and planned longevity, translates into applying creativity to work within the constraints of scarce computational resources and making this process accessible to others. I'll explore these key characteristics in practice through the discussion of two projects. The first project, *Uxn* (2021) by art duo *Hundred Rabbits* (Rekka Bellum and Devine Lu Linvega), consists of new software that can be used on older devices. The second project, *What Remains* (2018), by *Iodine Dynamics* (Arnaud Guillon, Chun Lee, Dustin Long, Aymeric Mansoux and myself) involved using old hardware from, and creating software for, an old device. *What Remains* can be considered permacomputing avant la lettre, as the term had yet to been invented when the project was realised, but its conception was informed by the same ideas that underpin what would come to be thought of as permacomputing.[21] *Uxn*, a small virtual machine (VM) made to run graphic and audio applications that *Hundred Rabbits* created in 2021, was developed with key permacomputational ideas in mind, informed by ethical as well as practical constraints.[22]

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[20] There are projects aimed at creating devices that have replaceable hardware modules, such as Fairphone and MNT Reform, but these projects do not associate themselves to permacomputing (Miquel, 2023; MNT Research, 2024). Permacomputing ideally involves making the repairability of electronic devices a legal requirement for *all* newly produced electronics, rather than developing one instance of a device with replaceable modules.

[21] The question of the relevance of the term might arise, when also considering practices that didn't use the term at the time of creation. The creators of *What Remains* have started using the term permacomputing to describe the work however. Next to that, the term has connected a lot of practitioners that were already working with some of the strategies which were later elaborated within the permacomputing community. This allowed for the strengthening and development of these dispersed, often individual and fragmented efforts. To come back to Tara McPherson's research on UNIX's modularity reflecting the increasing fragmentation of post-war political activism, application of the term permacomputing has allowed for alliance and community building.

Uxn is an example of design for energy descent, determined by ethical concerns but also strong practical constraints. The artists' move to life on a boat had confronted them with the high electricity and connectivity requirements of their artistic practice at that time. Working with proprietary software that would unexpectedly start a large auto-update while they were on a flimsy phone connection, or large applications suddenly draining their laptop's battery, became untenable. They started experimenting with emulators of older systems such as Apple's classic Macintosh with its Hypercard application and developer kit, and the Nintendo Entertainment System (NES), a video game console from the 80s. They realised these not only needed very little power, they also provided software preservation benefits, supporting the goal of design for longevity.[23] At first they considered developing for the NES. There are emulators on most systems and a thriving community maintaining them surrounds it, but their work required more than an 8 button controller. They started developing their own VM, operating system (OS) and programming language with the goal to perform their entire practice—website, tool and project development—on this tool set. To allow their software to run on a variety of old and new systems, they would need only to adapt the emulation software to each new platform, rather than having to port each piece of software individually.

Uxn also supports working with waste as a resource, since it can run on contemporary as well as older devices. It works on modern desktop computers, in a browser and has been ported to many devices and OS's, such as the Game Boy Advance, Nintendo DS, DOS, Raspberri Pi Pico and Teletype. It is build with low implementation complexity so that it is easy to maintain. It is customised to meet the needs of the two artists but is open source and free for others to use and write software for. The VM's design sets strict limits to what it can run. In general, running software in a VM takes more computing power than running a program natively, but because *Uxn* only runs small programs ranging from 10 to 15 kB on average, it uses little power and, as an added benefit, can run on many older devices.[24] The artists started adapting the way they work to the limitations of the environment they had created. This was both a good match with the limits set by their life on a boat, and a creatively satisfying experience (Linvega and Bellum, 2023).

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[22] A virtual machine is an emulation or virtualisation of a computer system. VM's can emulate specific existing or non-existing hardware and operating systems. For instance, they can be used to run software written for another operating system than the one currently running on a machine, or to play games made for game consoles no longer commonly available.

[23] Emulators of older computing systems can, under certain conditions, provide benefits for software preservation because these systems are no longer updated. The emulators need to be updated to run on newer computers but if you develop software for the system that is emulated, it will at least always remain functional on that system.

Uxn supports collective learning because it moves beyond individual practice and steers clear of awareness raising. It allows for community building and skill sharing to take place around a software and hardware ecosystem in the form of a virtual CPU (*Uxn*), a fantasy computer (*Varvara*) and a programming language (*Uxntal*).[25] Instead of creating individual projects that have a smaller environmental impact, *Uxn* is a computing environment that *Hundred Rabbits* uses to develop multiple projects while also opening it up to other developers and users. This reminds me of fantasy consoles, VM's simulating the restricted hardware of old 8-bit gaming systems.[26] Not because they technically resemble them—fantasy consoles are much more elaborate and heavy pieces of software—but because successful fantasy consoles gather a developer and player community around them. *Hundred Rabbits*' strategy to create a fantasy computer for their games and tools opens up the possibility of a community with a specific environmental focus forming around it. One of their side quests was to get people interested in learning about low-level computing, which *Uxn* succeeded in doing. It motivated people who only knew how to use JavaScript, to look into how computers work; it has inspired others to write programs for it; developers and artists have used it to create games, a game server and... a spreadsheet app. Documentation on how to program applications was written by Mexican artist and researcher Sejo Vega-Cebrián, aka Compudanzas. *Hundred Rabbits* were only ever present at the peripheries of these activities, but their thorough documentation allowed interested people to engage with the *Uxn/Varvara* ecosystem independently.[27]

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[24] The older the device, the more the computational overhead of using a VM instead of running a software natively starts to count, so this is by no means a universal solution. A five year old laptop will not struggle with a VM but a machine from the 1990s would.

[25] A fantasy computer is a VM of a non-existing computer, it is invented from scratch to match the functionality desired by the creator(s).

[26] The most well known fantasy consoles are, Pico-8 and Tic-80, which have been around since 2015 and 2017. Chip-8 is the predecessor of fantasy consoles. It was developed in the mid 1970s by Joseph Weisbecker to make it easier to program video games for the COSMAC VIP and Telmac 1800 8-bit microcomputers. Weisbecker's daughter Joyce became the first female commercial and indie game developer in 1976.

[27] This engagement with a larger audience was supported by the project's media coverage (Ong, 2022).

What Remains, a slightly older project, and one I was involved in making, also brings the permacomputational collective learning, design for energy descent, planned longevity and waste as resource into practice, but takes a different approach to that of *Uxn*. *What Remains* is an 8-bit game for the 1985 NES console. It blends visual novel and adventure elements in a story which translates real events from the 80s into an epic quest to save the world. The game allows players to explore and battle the dark side of the so-called digital revolution which began in that same decade. It uses strategies gleaned from disinformation campaigns used by the tobacco and oil industry in the 80s in an attempt to 'inoculate' the player against similar strategies used to spread disinformation about global warming today.[28] The game is developed for the original NES hardware. In line with the project's environmental story, the game is released as ROM and on reused and repurposed cartridges.[29] The ROM is available for free and can also be played in a NES emulator on any modern computer. The game itself and the tools created for the development of the game are Free/Libre Open Source Software.

To support collective learning, *What Remains*, instead of bootstrapping a new community, taps into existing communities of retrocomputing,[30] media archeology[31] and indiegame enthusiasts[32]. It connects the practices of preservation, circulation and reuse of old game consoles, cartridges and ROMs within these communities, with practices of repair and reuse from an environmental perspective. In this way, it supports collective learning around using waste as a resource, bringing together a group of people that treasure a 40 year old device, with a group of people interested in the story and gameplay. The permacomputing wiki distances itself from retrocomputing, yet there is more to it than restorative nostalgia in the form of conservation of artifacts from an often privileged childhood (Boym, 2001; Permacomputing wiki, 2022). As information scientists Yuri Takhteyev and Quinn DuPont argue, retrocomputing can move beyond preservation to creative assemblages of old and new elements as part of living practices (Takhteyev and DuPont, 2013). *What Remains* does exactly that, while its reflection on an old device's impact on the present, reviving it to tell a new story about media, connects strongly with the practice of media archaeology. The project brings together audiences from different interest groups and introduces them to each others' repair, preservation and storytelling practices.

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[28] The idea of psychological inoculation against disinformation is based on the research of social psychologists Sander van der Linden, Anthony Leiserowitz, Seth Rosenthal and Edward Maibach (2017). The game was developed during the 2016 US elections, the Brexit referendum and the first years of the Trump presidency, when the term 'post-truth' became widely used.

[29] ROM is Read Only Memory. Game ROMs are copies of the contents of the Read Only Memory chips of cartridge-based games and arcade machines that can be run on PCs with the help of an emulator which emulates an old game console or arcade machine's hardware.

[30] Retrocomputing is commonly understood as the use of older, already 'obsolete' hardware and software, today. The scene is dominated by a group that focuses on the restoration and preservation of old consoles, games and computers in their original state. Non-intrusive modifications and games made using new parts meant for the original hardware are welcomed but anything too invasive is often frowned upon. In this context, reuse of original parts for environmental reasons can be seen as damaging precious artefacts. However, there are also people more open to creative reuse. *What Remains* aimed at, and played with, this potential of (parts of) this community as both ally and opponent through a character in the game. The 'collector' non-player character follows the player through several scenes, trying to get hold of their invaluable, because unique, NES cartridge.

[31] Media archaeology is a field of research and artistic practice concerned with old media's impact on the present, specifically how these have shaped contemporary media and ideas about future media. There are a diversity of views and practices associated with media archaeology. An in depth discussion of it is outside of the scope of this dissertation. For a discussion of its potential in relation to the practices described in this chapter, please see Lorie Emerson's *Six (Difficult and Inconvenient) Values to Reclaim the Future with Old Media* (Emerson, 2022).

[32] Indiegames are games developed by independent game developers or small studios, without the financial backing and distribution channels of a large game company.

Creating new games for a 40 year old console practices using waste as resource and (un)planned longevity. NES consoles are not considered waste, they are still popular among a small crowd, but have for decades been replaced by newer models. Nintendo didn't plan for this longevity. Many consider creating new NES games an act of nostalgia, but we didn't choose the NES because it brings back memories, we see it as an instrument, now partly liberated from its original mainstream cultural context. Old devices have a lot to offer in terms of expression and creativity. You would not stop composing for a guitar because it was built in the 60s, why would you stop making new works on an 80s video game console? (de Valk and Mansoux, 2017). We wanted to show that many objects of mainstream computational culture have this potential of circulation and creative (re)appropriation as soon as you step out of the logic of mass consumerism and planned obsolescence. We wanted the content of the game to be reflected in the form, so it was important to have as little environmental impact as possible, while still reaching an audience. We chose the NES because of its long-lived hardware, readily available components, thriving community, and its games, which are very easily distributed because the console is emulated on a myriad of platforms and devices.[33]

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[33] It is remarkable that the NES and its game cartridges, released in 1985, are still circulating and are mostly in good condition. The hardware is 40 years old at the time of writing. The scene around NES ROMs is active and thriving, and could be seen as an example of digital preservation through a network of care, outside of an art or institutional context (Dekker, 2022)

The project's thorough documentation is part of the practice of collective learning and skill sharing custom among retrocomputing, media archaeology and permacomputing practitioners. We wanted to work on more than a one-off project and tried to establish a hardware and software environment that could be used for future projects and which also welcomes others to make use of them. In 2017, artist and programmer Dave Griffiths started developing the custom programming language *Co2* for the demo of *What Remains*. *Co2* allows writing a game for the NES in a higher level language build on Racket Scheme, which compiles into Assembly.[34] This was meant to make the process of game development easier and relatively more accessible. Programmer and game developer Dustin Long took over and developed this project further. Although he does think it brought some advantages, he is unsure if it was worth the trouble to develop and maintain *Co2* (Long, 2019). This aspect of the project didn't have the intended effect, but the careful documentation of both the development process as well as how to produce the physical cartridges using old components have advanced knowledge on developing for the NES. Both *What Remains* and *Uxn* are examples of how hands-on experimentation with alternatives to mainstream production and consumption cycles leads to a process of learning, including risk taking, failing and changing course, which provide insights into the potentials and pitfalls of computing otherwise.

Prefigurative politics

The last characteristic I wanted to describe is permacomputing's philosophy of change, the way the community imagines achieving the changes it seeks, which according to Heikkilä (2020) is to "give computers a meaningful and sustainable place in a human civilisation that has a meaningful and sustainable place in the planetary biosphere". At this moment, it envisions doing so not through strategic politics, such as organised protests or lobbying to create public pressure on politicians and corporations, but through a type of prefigurative politics. Social scientist Carl Boggs (1977, p. 4) describes prefigurative politics as "the embodiment, within the ongoing political practice of a movement, of those forms of social relations, decision-making, culture, and human experience that are the ultimate goal". He traces this practice to the 19th century anarchists, later practices by the syndicalists, council communists and the New Left. Permacomputing, at this moment, doesn't have a prominent political agenda that engages with social injustices related to class, race or gender, so it may sound like quite a leap to associate it with prefigurative politics in this tradition.[35] However, it can be argued that permacomputing has a political agenda, as expressed by Mansoux et al. (2023, p. 7): "permacomputing aesthetics could be understood as a politically driven kind of post-digital aesthetics". It approaches computing as the tip of the iceberg of an infinite growth-based economic system and approaches resistance to this system through small scale experiments that could model a larger scale reimagining of a post-growth society. The term post-digital aesthetics doesn't reflect the practice well however.

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[34] Assembly, or assembler, refers to any low-level programming language that closely resembles machine code instructions. Each assembly language is specific to a computer architecture.

According to media theorist Florian Cramer (2013, 2015), post-digital culture rejects the computer as representing technological progress and an improvement to older media, and is a resistance against the idea that ever higher resolutions and fidelity are perfecting representation. He discusses post-digital cultures as resistance against the military-industrial complex represented by the oligopoly of Silicon Valley corporations, while also saying they are not so different from the techno-utopias promoted by these, because both digital and post-digital utopias are based on the fiction of DIY, the idea of control over a medium and individual empowerment. He argues that in the frame of the post-digital, there are only two positions, for or against the digital, leaving no room for transformation. Software studies scholar Geoff Cox also reflects on the lack of agency embedded in the term. He argues that it is the temporal sense of incompleteness that gives people a sense of agency that might lead to social transformation, and that the post-digital condition is lacking this sense of temporality (Cox, 2015). If permacomputing is framed within the context of post-digital culture, it could be read as lacking the opening needed to imagine change.

Permacomputing does have a clear sense of historicity however, expressed by its refusal to define itself in ambiguous opposition to 'the digital'. Instead of a turn to the materiality of hand-crafted or so called analogue media, yet still mixed with and assisted by computing, it turns to the materiality of computing itself. It doesn't break with computing as a fixed and static phenomenon, it wants to reclaim and change elements of it while discarding others. Permacomputing doesn't define itself in a closing off, temporal relation to the digital (post) but asks how computing could be sustained (perma) in a way that allows the planet to sustain human life. It leaves room for people to "modify their lived circumstances knowing their experiences to be incomplete" (Cox, 2015, p. 160). It engages computing's history through media archaeological practices and manifests computing and digital information as material (Kittler, 1995).[36] It rejects maximalist techno-aesthetics for their environmental cost and drivers of overconsumption, and tries to demonstrate how computing can be done otherwise. None of this matches the term post-digital aesthetics. This leaves the issue Cramer identifies when discussing post-digital as similar to techno-utopian culture. Should the DIY and DIWO methods for tool and project creation be understood as fictions of empowerment, as Cramer described post-digital practices?

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[35] A statement on politics was added to the permacomputing wiki in May 2024 after a discussion on politics in the permacomputing XMPP channel made it clear that some participants thought permacomputing is about perfecting capitalism or that computing is apolitical. A participant was called naive and irrational for wanting to work towards a more harmonious society. The line "permacomputing is an anti-capitalist political project. It is driven by several strands of anarchism, decoloniality, intersectional feminism, post-marxism, degrowth, ecologism." was added to make it more clear from which motivations the project stems, even though the translation of these to a philosophy of change is not clarified at the time of writing (Permacomputing wiki, 2022).

Permacomputing tries to align means and ends, which is a form of prefigurative politics, based on the premise that the ends achieved are shaped by the means employed (Leach, 2013). This can relate to social organisation, by for instance questioning if an egalitarian and peaceful society can be realised through violent revolution lead by an elite. It can also relate to technology by questioning if sustainable human societies can be achieved while continuing to rely on types of technology that accelerate environmental decline. As sociologist Wini Breines argues, in *Community and Organization: The New Left and Michels' "Iron Law"*, an analysis of the politics of the New Left, the movement's refusal to create hierarchical organisation did not mean the movement was apolitical.[37] Their impulse toward community *was* its political content, an embodied relationship to power that was practised alongside strategic politics (Breines, 1980). The attempt to change computing practices through DIY and DIWO, a collective process of learning, can be considered as a way to bring means and ends into alignment, an embodied relationship to technology, and a resistance to the centralised power of tech companies. However, the bridge the New Left made between prefigurative and strategic politics is not made by the permacomputing community at this moment.

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[36] It doesn't limit its discussion of computing to its material aspect however. I use the term media archaeological, again, in alignment with Emerson's interpretation of it as a project of reimagination; working with existing alternatives to hegemonic systems by "recovering past media traditions for the sake of a reimagined future" (Emerson, 2022). Her approach is an attempt to bridge media archaeological theory with the urgencies of the socio-political realities faced today.

[37] Breines describes the way the New Left approached organisation as an attempt to break with sociologist Robert Michels' 'iron law of oligarchy', a theory claiming that democratic organisation at a large scale will inevitably lead to rule by an elite, because its scale doesn't allow for direct democracy (Breines, 1980).

This might be partly due to the loosely knit and geographically scattered group of people, a community of practice, mostly communicating online. A community of practice is an interlinked web of people, artefacts and actions, learning together outside of formal or institutional organisation. The term was introduced by social anthropologist Jean Lave and educational theorist Etienne Wenger to describe learning in a network of relations, taking into account the socio-political organisation of practice, its content and of the artifacts involved (Lave and Wenger, 1991). Wenger further elaborates on the term, describing it as: "[...] groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly" (Wenger and Trayner, 2015, p. 2). Star used the term to discuss the ways people form communities and learn collectively, outside the boundaries of institutions, permitting a relational and ecological way to describe people, objects and ways of working together (Star, 2015). Even though the larger permacomputing community is too loose-knit to claim they are prefiguring social relations, it is prefiguring relations with technology, building new roles for technology in people's lives from the trash of the present.

Artist Nancy Mauro-Flude reminded the permacomputing mailing list of Philip K. Dick's observation that "...the clue lies there...symbols of the divine show up in our world initially at the trash stratum" (Dick in Davis, 2006, p. 303) She points to the potential of working with the discarded, objects that are freed from their utilitarian role.

> "They reveal the power of subjective approaches and how modding apparatuses can arouse social reflection and alternate participation and shift ones' conception of technology but also of its embodied reach into our everyday life." (Mauro-Flude, 2016).

This engagement with discarded technology isn't a fiction of empowerment. The practice doesn't aim at overthrowing capitalism, it aims at this embodied relation to power, confronting the effect of maximalist techno-aesthetics in everyday practice through a reimagining of what computing technology could be. It puts this into practice through developing projects that can range from skill-sharing and storytelling, to software and hardware development for individual or community purposes, from talking to organisations about their potential longer use of computing equipment to potentially building alliances with groups involved in strategic politics in the future.[38] Permacomputing empowers at these scales of intervention. Is this turn to prefigurative politics an echo from the practices discussed in the previous chapter, and has the practice inherited other elements from that era?

Echoes from past practices

In the previous chapter I discussed soft technology and Appropriate Technology, to trace the history of some of the ways people have attempted to redefine technology's role in the climate crisis. In this section I will look into ideas from that era which have been inherited by permacomputing, to understand in which new ways it challenges hegemonic understandings of technology's role in the climate crisis. In the case of permacomputing, the most obvious trace is its inspiration from permaculture, which stems from the afterlife of the back-to-the-land movement of the late 1960s (Centemeri, 2019). Bio-agronomist Bill Mollison and his student David Holmgren tried to support this movement in their efforts of subsistence farming, since many had no experience with farming at all. They coined the term in their 1978 book *Permaculture One*, describing permaculture as a system of permanent agriculture (Mollison and Holmgren, 1990).[39] They took inspiration from a diversity of sources. For the development of their methods of sustainable agroforestry they incorporated Tasmanian Aboriginal and Native American practises. For inspiration on social organisation they looked at the writings of Ivan Illich, who sought to reduce dependence on the wider industrial system through local interdependence.[40] They were influenced by Peter Kropotkin in their ideas on cooperative and symbiotic relationships, improving the environment for all beings involved (Centemeri, 2019). Last but not least, they acknowledge being indebted to the work of Stewart Brand and his *Whole Earth Catalog*, especially for the vision of the self as the ultimate driver of social change and the view of the world as an interconnected system of energy and information flows and technology as an empowering force.[41] Sociologist Laura Centemeri (2019, p. 10) describes how this vision sees political change as "the result of empowered individuals becoming 'comprehensive designers' who are able to see the 'whole picture' ". Mollison and Holmgren appropriated indigenous knowledge and mixed it with a countercultural fascination for cybernetics inspired systems thinking, reflected among other things in their use of abstract design principles. Permacomputing copied the approach of abstract design principles to inform practitioners' designs.

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[38] The smaller group active around the permacomputing wiki is working towards closer collaboration and connections with other transformational practices and social movements.

[39] *Permaculture One* was published in the same year as *Soft-Tech* (Brand and Baldwin, 1978).

[40] A more detailed discussion of Illich's ideas is included in the *Damaged Earth Catalog* entry *Convivial Technology* (see portfolio).

Permacomputing took inspiration from permaculture, which took inspiration from, among other things, soft technology, which was based on the idea that social change could be accomplished by 'comprehensive designers', enlightened individuals using the 'right' technology, tools that would change the world one hand at a time. Permaculture's philosophy of change and use of cybernetics inspired abstract design principles, makes clear that permacomputing indirectly inherited quite a few elements from soft technology. This brings me to what Heikkilä states to be the overarching premise of permacomputing: the idea that the use of computers can be justified if it has a strengthening effect on ecosystems (Heikkilä, 2020). This is a problematic inheritance from soft technology and permaculture because it is very abstract and all-encompassing. This makes it incredibly hard to interpret and translate into practice. When taken to its extreme, it could mean abolishing computing altogether, but it could also mean computing is unquestionably part of environmentalism. When comparing this to the actual practice of individuals and groups using the term, it turns out to be something much more specific: a collection of strategies to reduce the negative environmental (and social) impact of technology in the field of art and cultural production. Something similar happens in permaculture, with as first principle: "[c]are of the Earth: [p]rovision for all life systems to continue and multiply" (Mollison and Holmgren, 1990). As sociologist Terry Leahy (2021) observes in *The Politics of Permaculture*, it is unclear how permaculture design principles translate to practice and notices a discrepancy between what permaculture claims to be, phrased as broadly as environmentalism in general, and what it is: a specific type of sustainable agriculture. In his view, the emphasis on universal and abstract principles stands in the way of learning and teaching accessible, up to date, concrete skills and knowledge (Leahy, 2021). Permacomputing design principles are currently also phrased in universal terms such as its first principle: care for life. The wiki explains:

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[41] Laura Centemeri points out the proximity of permacultural thinking to what Turner (2006), in *From Counterculture to Cyberculture*, describes as the particular politics and world view promoted by Brand and the *Whole Earth Catalog*, based on personal integrity, individualism, collaborative sociability and soft technology. She sees the controversial aspects of his vision expressed in the sentence: "We are as gods and might as well get good at it" and I wholeheartedly agree. (Brand, 1968, p. 1; Centemeri, 2019).

> "This is the ethical basis that permacomputing builds on. It refers to the permacultural principles of 'care for the earth' and 'care for people', but can be thought of as the basic axiom for all choices. Create low-power systems that strengthen the biosphere and use the wide-area network sparingly. Minimize the use of artificial energy, fossil fuels and mineral resources. Don't create systems that obfuscate waste." (Permacomputing wiki, 2022)

The mismatch between its all encompassing overarching goal with the actual situated practice, hinders the changes permacomputing seeks to be realised and creates an accessibility problem. For a newcomer, it is hard to understand what these principles mean concretely and how to *practice* them. How do you provision for all life systems to continue and multiply when standing in your allotment? How can you strengthen the biosphere from behind your laptop?

Another indirect inheritance from soft technology and permaculture is the lack of reflection on what stands in the way of the practice becoming widely adopted. This directly relates to Winner's observations about the Appropriate Technology movement in the US; the lack of knowledge regarding why certain technologies became dominant and others disappeared and the related lack of strategies developed to confront the social and political forces that might work against the movement. Heikkilä describes the goal of permacomputing as to "give computers a meaningful and sustainable place in a human civilisation that has a meaningful and sustainable place in the planetary biosphere" (Heikkilä, 2020). This is a hard goal to work towards without confronting computing's role in neoliberal capitalism. Its role in automating labour, networked forms of production, temporary contract based employment, military and geopolitical power struggles and as I argued in chapter 1, how it currently enables the narrative of a seamless merge between capitalism and environmentalism. Permacomputing texts, until now, identify the narrative of progress, technological monoculture, maximalist techno-aesthetics and the subsequent ever-increasing energy use, as causes of the growing negative environmental impact of computing (Heikkilä, 2020, 2021b; Permacomputing wiki, 2022; Mansoux *et al.*, 2023). There is no strategic confrontation with what caused this narrative and monoculture to become dominant, nor with what might block widespread adoption of the practice.

Prefigurative politics proposing alternatives to growth-based economies, as practised in different ways in permaculture and permacomputing, means going against the grain of free market capitalism (Leahy, 2021). This often means working longer and harder for less pay or in the worst case, not being able to stay afloat financially. Leahy interviewed 19 permaculturalists, some of who saw technology as a way to make capitalism sustainable, an ecomodernist view.[42] Most favoured a type of radical reformism, oriented around small decentralised self-organised groups locally modelling aspects of the new society. Permaculture has no unifying political strategy within the movement and Mollison is explicitly apolitical. In his writings Mollison doesn't indicate seeing anything hindering this new, post-industrial economy within capitalism and he sees no need for political action: if you change locally, larger systems will follow (Leahy, 2021, p. 131). This idea was shared broadly among back-to-the-landers in the 1970s, in sharp contrast with the radical politics of the early 1960s, of for instance the New Left (Turner, 2006, p. 37). Leahy points out that this is unfair to small farms struggling to survive because of the hardships encountered when trying to earn a living using methods that are incompatible with free market capitalism (Leahy, 2021). It is no accident that industrial agriculture ended up environmentally unsustainable; cutting costs of production is highly rewarded in the current dominant economic system. The problems encountered by prefiguring an alternative are the result of systemic issues, not personal failure (Leahy, 2021, p. 137).

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[42] As explained in chapter 1, ecomodernism is a school of thought that believes in the decoupling of economic growth from environmental depletion. It imagines a 'good anthropocene' in which technology reduces humanity's dependence on nature and directly denies the findings of *The Limits to Growth* (Meadows *et al.*, 1972; Asafu-Adjaye *et al.*, 2015). Stewart Brand is one of the 18 authors of *An Ecomodernist Manifesto* (Asafu-Adjaye *et al.*, 2015).

What are these communities up against?[43] The tech industry is implicated on an even deeper level than industrial agriculture, because tech companies do not only compete with each other for market dominance, they are key players in military projects and geopolitical power struggles, and provide other industries with the means to become more competitive, by offering products that help them cut costs through the control and automation of labour (Smith, 2019; Hampton, 2023). Last but not least, the tech industry is key to the narrative which unites capitalism and environmentalism. Permacomputing, as discussed earlier, hints at computing's role in capitalism yet hasn't developed strategies to confront the forces working against the practice.[44] Degrowth economics, the heart of any challenge to environmental destruction, is at odds with capitalism. Permaculture as well as permacomputing are degrowth practices, they propose an alternative to the endless extraction of natural resources, turning them into waste, to achieve maximum shareholder value, hence they will not easily be embraced within current economic and political conditions (Demaria and Latouche, 2019; Hickel and Kallis, 2020; Hickel, 2021; Leahy, 2021). Permacomputing runs the risk of following soft technology and permaculture's path into dreams of a 'simple' and rustic lifestyle aided by technology without questioning its larger systemic embedding and the privilege associated with being able to pursue such a lifestyle in the first place.[45] Permaculture hasn't revolutionised agriculture in the 46 years since its inception, which doesn't mean it isn't a valuable practice, it means its goal of provisioning for all life systems to continue and multiply is not aligned well with its methods, a scalar mismatch (Liboiron, 2021).[46] Seeking meaningful alliances with other social movements such as the right-to-repair movement and articulating the role of computing within the economic system could support the larger goals of permacomputing while giving the prefigurative politics a clearer political frame.[47]

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[43] Sociologist Darcy Leach notes that there is little empirical research done to assess the success of prefigurative politics as strategy for social change and refers to Boggs for a study of their decline (Boggs, 1977; Leach, 2013). Leahy's study of the successes and failures of permacultural prefigurative hybrids of gift economy and capitalism, 3 in-depth case studies (IDEP in Bali, the Chikukwa Permaculture Project in Zimbabwe and a CSA farm in Wales), demonstrates these often struggle to survive exactly due to this clash between non-capitalist economic models of exchange within a capitalist system (Leahy, 2021, pp. 131–169).

[44] Perhaps it is unfair to demand this of a practice that is still developing, yet it turned out to be such an important missing element in the Appropriate and Alternative Technology movements that developing strategies early on could strengthen permacomputing's potential.

[45] This also creates the risk of easy incorporation into business as usual. If computing can have a place in an environmentally friendly lifestyle, this suggests high technology and environmentalism are compatible, and no radical changes are needed as long as everyone buys the right technology. See the discussion of *Building the Better Mousetrap* by Winner (1986) in the previous chapter.

[46] A scalar mismatch is a conflation of relations, of problem and solution operating at different scales.

An access and diversity problem

This mismatch between methods and goals is also reflected in the way access and inclusion in terms of class, race, gender and disability are approached in both permaculture and permacomputing.[48] There is no explicit interrogation of how larger societal inequalities might be reproduced through these practices and how to work towards positive change. To give an example, permaculture has notoriously high barriers of access due to its Permaculture Design Certificate courses, which are expensive.[49] Next to that, not everyone has access to land and according to research by sociologists Timothy Haney and Aulora Morrow (2023), permaculture tends to be practised primarily by white middle class people and—in the case of the North-American practitioners they interviewed—they weren't very aware of the settler colonialist logics around ownership of and access to land supporting their practice. They also found that many of the practitioners they interviewed didn't connect permaculture with indigenous knowledge, even though this is the origin of many of its principles, indicating a lack of decolonial focus and sensitivity (Haney and Morrow, 2023). Leahy (2021, pp. 170–192) also identifies less participation of women and BIPOC in the movement, internationally, from the start, with its two white, male founders who created their system based on indigenous knowledge without involving indigenous people, and Mollison having attempted to exclude a group of women leaders from the movement in the late 1990s (Ferguson and Lovell, 2015).[50]

If permaculture faces issues of inclusivity and decolonial awareness, how does permacomputing fare, being a practise engaging with an industry infamous for its lack of inclusion and its historical origins in labour control through automation? Permacomputing thankfully doesn't have an expensive certification scheme, no expensive equipment is needed, and the wiki states it is the home of a community of various cultural, ethnic and professional backgrounds aiming to be welcoming to people of various backgrounds and to provide a non-toxic and harassment-free environment (Permacomputing wiki, 2022). Yet approaching the issues of classism, racism, sexism and ablism at the level of the community could be strengthened through strategic alliances with social movements. Technology in general has problems of equal access and inclusion and, according to STS scholar Christina Dunbar-Hester (2020), these problems tend to be worse in voluntary open technology initiatives. The voluntary and non-institutional nature of the groups means there are no human resource departments following equal opportunity legislation. And then there is technology itself:

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[47] I will not develop the ways these alliances could be created within this dissertation, however valuable a venue of exploration this is. It isn't the focus of the main thesis, nor of this chapter, which aims at learning in dialogue about the potentials and blind spots with a strong emphasis on the new challenges posed by the practice of permacomputing to dominant definitions of technology.

[48] The paper *Permacomputing Aesthetics* discusses the place of art, design and cultural works in relation to questions of class and privilege. It points to the risk of permacomputing ending up as a hobby for the privileged, romanticising practices triggered by precarity and poverty. It states there is a lot of work to be done to understand its own situatedness in order to avoid this (Mansoux *et al.*, 2023).

[49] An online and self-directed Permaculture Design Certificate course in the US currently costs 550 dollars. A course on location in the UK costs around 1000 pounds.

[50] Sociologists Rafter Sass Ferguson and Sarah T. Lovell (2015) researched diversity of participation in the international permaculture movement in 2015 and found that while participation of women at that time was at or above parity (53%), there was a white supermajority (96%).

> "Technology is, if not always already of the dominant culture, always laden with a legacy of division. Technical cultures are world-making: they sort people and present barriers to entry by design." (Dunbar-Hester, 2020, p. 242)

This again points to the need of an articulation of the role of technology in society more generally, to avoid a sole focus on fixing aspects of technology itself, while ignoring how it came to be the way it is. As Dunbar-Hester argues, the inequalities of participation aren't caused by lack of effort within a small community, these are societal and systemic problems. She points out that aiming for representation would only provide a very local solution, really addressing this problem requires social justice activism at a much larger scale, not focused only on one group or one technology (Dunbar-Hester, 2020). These aren't mutually exclusive though, both are needed: working locally is a valuable way to make meaningful changes that directly benefit a specific community, and being involved in strategic politics aimed at social justice supports transformation at a larger scale. Permacomputing texts explicitly express a wish for diversity, pluriversality and in agricultural terms: a polyculture (Heikkilä, 2020; de Valk and Heikkilä, 2022). In resistance to universalist monopolies, there is a wish to hear a diversity of voices about alternative ways in which technology could feature in society. This clash between goals and methods, scalar mismatches, is food for the collective learning process and discussion within the community. The study of the history of permaculture as well as soft technology and Appropriate Technology provides insights into blind spots that can help strengthen the practice's transformational potential.

Challenges to prevailing definitions of technology

Besides the challenges inherited from past practices, permacomputing also brings new potentials, in the way it challenges prevailing definitions of technology. In this section I'll discuss what these are, what story about technology's role in the climate crisis is told and on which scale this narrative operates.[51] In the previous chapter the attempts at a radical redefining of technology resulted in new words being coined to reflect these shifts in meaning. Unfortunately, these attempts were overshadowed and eventually stopped by the tech utopian views promoted in the WEC and CQ and later by *Wired* magazine.[52] Buckminster Fuller's concept of ephemeralisation made it from the pages of his 1938 thought adventure to the lips of a US president; and became the decoupling myth I discussed in the first chapter, reframing Western industrial capitalism from cause of, to the only escape from, environmental collapse. What does permacomputing have to offer in terms of counter-narrative and at what scale does this operate?

Careful observation and 'not doing'

Despite the at times ambivalent positioning of technology as the means to environmentalism as well as the cause of environmental damage, the overall message and practice of permacomputing is strongly focused on the latter. Technology is seen as part of the problem, not the solution. This is most clearly expressed in the emphasis on careful observation.[53] Technology needs to be at the service of a healthy social and natural environment and texts about permacomputing emphasise the need to observe first, to be able to take the time to carefully weigh costs and benefits, and if the former outweigh the latter, to not rely on tech. Four members of artist collective Varia in Rotterdam, Alice Strete, Luke Murphy, Simon Browne and Danny Tirthdas van der Kleij, practiced careful observation at the start of a project that aimed at making Varia's tools and research public and accessible.[54] They called it 'taking stock' (Strete *et al.*, 2024).[55]

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[51] The interrogation of scale in this section is inspired by the work of discard studies researchers Max Liboiron and Josh Lepawsky. In *Discard Studies* they discuss scalar mismatches which they often see in environmental activism (Liboiron and Lepawsky, 2022). They show how waste happens on multiple scales and across multiple systems, and that therefore research should be done in a situated and partial way, steering clear of the universal 'god trick' that may lead some to conclude the human species to be the cause of environmental decline, leading to harmful erasure of differences and inequalities as well as showing no possible venue for change or intervention (Haraway, 1988; Liboiron and Lepawsky, 2022).

[52] *Wired* is an American magazine published since 1993, featuring content about technology and culture. It is in many ways the successor or WEC and CQ, with executive editor Kevin Kelly, previously editor of the *Whole Earth Review*, promoting the 'Californian Ideology' (Barbrook and Cameron, 1995; Turner, 2006).

> "Taking stock is a strategy based on permaculture's humble first principle to 'observe and interact'. The aim of this initial step is to take time to engage with a location to understand what is going on with its various elements." (Strete *et al.*, 2024)

They chose for this observation period to avoid rushing into the implementation of infrastructure before knowing what is actually needed by the collective. Taking time to 'take stock' allowed them to involve others and to come up with ways forward as a group. After researching and observing, they realised that the reasons they were unhappy with their website and archive were of a social, not a technical, nature. Not giving in to the impulse of making something new led them to consider investing more time in skill sharing, reflecting on decision-making processes and working on access and inclusivity. An outcome of this process was the decision to prioritise listening to the collective, because improving social processes will also improve the functioning of the website and archive for both Varia members as well as the public.[56]

Permacomputing challenges dominant views on technology through this emphasis on observation. There are many people eager to learn what can be done concretely and practically to limit environmental damage caused by computing. The hard part, it seems, is understanding that in terms of sustainability, most of it comes down to not doing, not buying, not adding. Yet the initial response is often an impulse purchase of a solar panel and a Raspberry Pi (de Valk and Heikkilä, 2022). In permaculture the principle of careful observation before intervening in an ecosystem makes sure that you are able to asses if your intervention is needed and if so, how it can be done with minimal disturbance and waste of energy. Applied to computing, this challenges both techno-solutionism and its related consumerism, and helps calm the 'where-do-I-buy-the-kit' reflex. It is not about access to tools, it is about understanding the needs of communities and only using computing if it supports those needs, and doing so in a way that promotes social and climate justice.[57]

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[53] Even though here careful observation refers to the permacultural practice of witnessing a piece of land and its flora and fauna for a while before intervening, it is not entirely unrelated to Tsing's (2015) 'arts of noticing', in *The Mushroom at the End of the World*. She speaks of reorienting our attention away from human-centred tales of (industrial) progress and ruin, towards multi-species, polyphonic assemblages, because these have something to tell us about collaborative survival. Permaculture's observation doesn't project a plan for a crop yield onto an 'empty' patch of land but instead witnesses a living piece of land's rhythms of growth, decay and regeneration throughout a year's seasons.

[54] Varia is a Rotterdam space developing collective approaches to everyday technology. Varia maintains and facilitates a collective, FLOSS-based infrastructure supporting their work.

[55] In *Stock Taking Sense*, the authors state that as a result of their involvement in the permacomputing community, they began looking closer at permacultural principles.

[56] The path towards these choices started with Luke Murphy sharing an anecdote of someone observing a piece of land for a year, seeing it move through the seasons, before intervening. This made them think about the value of understanding how the website and archive turned out the way they did, by looking at the ways the collective dealt with it and each other, over a period of years.

Permacomputing's emphasis on observation, on not doing, not buying and not making, is not only resisting solutionism but also addresses a problem within the context of the cultural sector's creative industries: its push for novelty and the use of art for lending legitimacy and a friendly face to new technologies based on extractivism, to oil companies, gentrification projects and more, so called 'art-washing' (Gómez-Barris, 2023). This practice is stimulated by philanthropists and technology companies themselves, such as government surveillance service provider Palantir sponsoring an art show in Leipzig in 2023 or OpenAI lending artists 'early access' to Sora to lend their product a friendly face (Artwashing Leipzig, 2024; Schrader, 2024).[58] More generally, funders encourage the use of the latest technologies by artists, such as blockchain between 2015 and 2022, and at the time of writing AI, AR and VR. Something similar takes place in academia, for example, the promotion of 'ethical AI' by universities, funded by Big Tech, that successfully delayed regulation of an industry which develops tools for mass surveillance and warfare (Ochigame, 2019). These technologies are developed and produced for military-industrial purposes but the connection between works of art in a gallery and facial recognition used to identify targets in a war-zone is hard to make. The technology, and the companies producing it, capitalise on the friendly face granted to them through the arts (Cain, 2023).[59] Permacomputing's careful observation and challenge to maximalist techno-aesthetics in the realm of art and cultural production by working with self-imposed limits is a resistance against art-washing.

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[57] India's Swadeshi movement, which was active at the beginning of the 20th century, provides and example (at a much larger scale) of what careful preliminary observation of community needs, as embedded in larger political and economic systems, can achieve (as opposed to thinking in terms of available new technology and efficiency). Swadeshi's symbol was the spinning wheel, but not because the tool was its main orientation. What mattered was the socio-economic organisation allowing small-scale village industries to thrive so that the majority of people, who lived in villages, would be served by technology rather than technology putting them out of work. See the previous chapter for a more detailed discussion.

[58] OpenAI didn't pay these artists and their products are trained on the works of millions of artists and writers. Sora, a text-to-video tool, once released, will very likely put a lot of creators and artists out of work.

Permacomputing's prefigurative politics as a model for change are not based on ideas inherited from soft technology. There is no belief in a change of consciousness as a path to social change, no slide projectors, LSD or meditation as ways forward. There is also no green consumerism at play, it is at its heart an anti-consumerist practice aiming at reducing the production of new devices by using already existing and obsolete technology. Permacomputing practitioners are practising according to ethical principles relating to larger socio-political issues: something activist and plastic pollution researcher Max Liboiron calls 'axiology-in-praxis' (Liboiron, 2021).[60] As discussed earlier, the attempt to change computing practices at the scale of DIY and DIWO can be regarded as a way of bringing means and ends into alignment, an embodied relationship to technology, and a resistance to the centralised power of tech companies. Practitioners are prefiguring relations with technology, building new roles for technology in their lives in the ruins and from the trash of the present. This is, at a modest scale, certainly not apolitical and as long as it is evaluated at the scale on which it operates, effective direct action.

> "Our species will survive neither by totally rejecting nor unconditionally embracing technology—but by humanizing it: by allowing people access to the informational tools they need to shape and reassert control over their lives." (Gershuny and Korot, 1970, p. 1)

Permacomputing gives shape to new forms of *Radical Software*'s plea, quoted above, to give people access to the means of media production so that they can reassert control over their lives, but leaves out the video therapy and cybernetics (with perhaps the exception of the design principles). In the 70s this taking control was a resistance against the power and monopoly of TV broadcast companies. The idea that these companies held great power over public opinion was apt. The idea that breaking this monopoly, through self-producing and distributing content, would accelerate cultural and political change, was problematic in hindsight. However, for a very brief moment, because of the appearance of the affordable Portapak video recorder, giving people access to media production, social movements and media movements converged in the drive for social change without mediation by broadcasters or the art world (Rushton, 2024). It didn't last, and Radical Software's video activism was defanged and absorbed by galleries and museums. Permacomputing started out in the field of art and creative coding, and it aims at a far more pervasive medium than TV. Ironically, computing becoming pervasive was aided by *Radical Software*'s promotion of the idea that access to information would level power hierarchies. Permacomputing has the potential to undergo an opposite development to *Radical Software.* It could move from an art context into an activist one, if it takes a different stance than its predecessor towards the medium of computing. *Radical Software*'s history shows it is not only important to take control over a medium, it also needs to be understood as part of larger economic, social and political systems and changed to meet the needs of a particular community.[61] It is not about access to tools but about bringing the means of communication (as the means of production) under community control, not to replace Big Tech but to provide people with choice about how they wish to organise themselves and to provide a safe space, a shelter from surveillance, disinformation, hate speech and other harmful aspects of the commercial Internet.[62]

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[59] An example of this is Boston Dynamics leasing some of their robot dogs 'Spot' to artist Agnieszka Pilat, who makes them paint. The robots are sold to the military, police and mining companies. Earlier, Boston Dynamics released videos of their robots dancing.

[60] Axiology-in-praxis is Liboiron's term for the approach of every aspect of everyday practice as a manifestation of one's values (Liboiron, 2021, p. 122).

An equally important contribution of permacomputing to redefinitions of technology is its challenge to capitalist sorcery's sorting spell that uncritically dismisses everything that is older as regressive and nostalgic. Not only is technology fetishised across the political spectrum, the recent uncritical embrace of AI tools for creative production demonstrate how easily technology can mesmerise and enchant, leaving critical interrogations backed up by facts and sound argumentation in the dust, while people gasp at photorealistic videos and well articulated texts generated through an automated regurgitation of the work of millions of artists and writers. With the worrying increase in water and electricity use associated with generative AI based on the training of large models, during an ongoing environmental crisis, it is difficult to understand why so little attention is given to the social and environmental costs of this new 'toy', that ultimately will cost many people their job, exacerbate the climate crisis and disadvantage marginalised people.[63] Mansoux et al. (2023) carefully explain that permacomputing doesn't make use of obsolete devices because of a restorative nostalgia, a longing for a past that was simpler, when computing was good, because there never was such a time. The authors point to a more practical reason: old devices are accessible, often cheap, readily available and easier to hack. Instead of longing to restore the device to its old purpose, permacomputing looks at it as liberated from its old use, to be hacked and creatively adapted to a new one. This is an experimental type of retrocomputing, mixing old and new elements in creative assemblages (Takhteyev and DuPont, 2013). Instead of being fearful of being perceived as nostalgic or dismissing associations with retrocomputing, permacomputing could own this embrace of e-waste as liberated (zombie) media more fiercely and forge alliances with retrocomputing, media archaeology and other practices breathing new life into the discarded.[64] Appropriate Technology didn't achieve its goals in the Global South due to the feminisation of solar power as 'poor woman's energy' and its associations with poverty, it didn't work in the Global North due to the consumerist approach of soft technology becoming dominant (Winner, 1986; Chatterjee, 2023). Permacomputing's anti-consumerist, creative and forward looking methods challenge capitalist sorcery's most powerful spell.

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[61] One could argue that working on self-hosting and providing network services to a community is a comparable escape as the back-to-the-landers withdrawing from society in the 70s. However, the commercial Internet is much more like a new (electronic) frontier with colonial tendencies, and an escape from the regulated spaces of traditional media. Trying to establish spaces bound by ethics and accountability is not escapist, it is an effort to denormalise the dominant view that the commercial Internet represents society.

[62] In *Means of Communication as Means of Production*, originally published in 1978, Williams argues that because means of communication are not only forms, but also means of production, because "communication and its material means are intrinsic to all distinctively human forms of labour and social organisation, thus constituting indispensable elements both of the productive forces and of the social relations of production." (Williams, 2005, p. 35) He criticises McLuhan's technological determinism, which can also be found in the pages of *Radical Software*, assuming uses of media are determined by their technical properties, abstracting media from the economic, political and social relations they are part of.

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[63] As mentioned in chapter 1, the impact of AI on the environment is difficult to ascertain because industry is not sharing data about water and energy use. Li et al. (2023) estimate global AI demand will require 4.2 to 6.6 billion cubic meters of water in 2027, which is 4 to 6 times the annual water use of Denmark. Training neural network models for NLP can emit more than 626,000 pounds of CO_2; about five times the lifetime emissions of the average American car including its manufacture (Strubell, Ganesh and McCallum, 2019; Crawford, 2024).The negative impact of AI on marginalised groups is discussed in the work of computer scientists and activists Timnit Gebru (2020; 2024) and Joy Buolamwini (2018).

[64] With the term 'zombie media', new media theorist Jussi Parikka and artist and designer Garnet Hertz (2011, p. 1) call for a re-politicisation of media archaeology, through a development of both theoretical as well as practice-oriented methodologies of design informed by environmental concerns. They propose complementing the textual methods of media archaeology, "excavating histories of dead media, forgotten ideas, sidekicks and minor narratives", with a material one, a reviving of dead media through hardware hacking methodologies.

> "Discarding is one technique of power among many. Discarding involves rejecting, wasting, annihilating, destroying, prioritizing, or externalizing some things in favor of others. This is a normal part of all systems. Discarding isn't inherently bad [...] but it does produce unevenessess that have different effects for different systems, environments, people, and ways of life, especially if those systems become dominant." (Liboiron and Lepawsky, 2022, p. 62)

The tech industry's PR campaigns teach consumers in the Global North how to waste, in order to keep generating profits and to help other businesses profit, all at great cost to the environment and people. The increase in e-waste is deeply entangled with systems of power (Liboiron and Lepawsky, 2022). Although perhaps modest, challenging this narrative through practice and working examples—in alliance with connected practices such as those of the small web, repair culture and low tech—is effective at the scale of direct action and of discourse. A counter-narrative defamiliarises the naturalised idea that technology is part of an evolution towards the good society, that the next iteration is always an improvement and that anything that challenges this is ultimately a backward and irrational choice of panicked individuals, fear mongers and saboteurs. Permacomputing does so in a way that demonstrates by example that this doesn't mean going back to the stone age. Because ideas are tested it does show that repair and reuse require accepting intermittency in connectivity and availability, of slowness and a different aesthetics, which means it isn't a universal good but a situated practice that denormalises the wastefulness of industry unequally affecting disadvantaged communities globally.

Conclusion

In this chapter, I tried to answer which of the ideas from the previous chapter can be found in permacomputing practice today and in which new ways it challenges hegemonic understandings of technology's role in the climate crisis. Permacomputing made a quick development in the past four years, from blogpost to a growing community of practice that made the national news in France. I discussed its key characteristics as it is currently practised in the context of art and cultural production: a set of strategies resisting maximalist techno-aesthetics; embracing self-imposed limits as a method to think creatively about what needs doing; and considering how this could be done using substantially less resources. I introduced two projects that show how permacomputing, applied to art practice, means design for energy descent, using waste as a resource through repair and maintenance, and supporting collective learning through skill sharing, community building and creating alliances between different practices such as retrocomputing and media archaeology. I discussed how permacomputing practice aims for diversity as a situated approach to technology, rather than proposing a North-American military-industrial way of working and world view as so-called 'universal'. Permacomputing's philosophy of change takes the shape of prefigurative politics both in ways of organising within the community of practice, as well as in the way it aligns means and ends in an embodied relation to technology, resisting the centralised power of tech companies. It confronts the effects of maximalist techno-aesthetics in everyday practice, by giving expression to what degrowth computing might look like but, at the time of writing, has yet to bridge prefigurative and strategic politics.

I discussed echos from the past in permacomputing's indirect inspiration from the *Whole Earth Catalog*; its individualist philosophy of change and use of abstract design principles that result in a mismatch of its all encompassing overarching goal with the actual situated practice, which hinders the changes it seeks to be realised and also creates an accessibility problem. The practice's emphasis on computing puts it at risk of inheriting a focus on tools and computer literacy, lacking an understanding of why certain technologies are dominant, and of strategies that confront the social and political forces that might work against it. It hasn't developed strategies confronting computing's role in capitalism and is only just starting to pay careful and explicit attention to questions of class, ethnicity, gender and disability and how certain inequalities might be reproduced through computing practices. Without articulating computing's embedding in larger systems such as local and global economies, it runs the risk of growing closer to privileged lifestyle than to activism.

Permacomputing does however propose new and strong challenges to prevailing definitions of technology. It positions technology as part of the causes of climate change, most clearly expressed in its insistence on degrowth—design for energy descent, using waste as resource—and careful observation—evaluating community needs first, before initiating the design of new infrastructure—and 'not doing'—carefully evaluating if a problem is of a social or technical nature and in case of the former, not relying on technology for a solution. This practice results in a commitment to skill sharing, access and inclusivity and attention to decision making processes, as opposed to 'fixing' a technology. Permacomputing's prefigurative politics are a way to bring means and ends into alignment, building new roles for technology in situated ways. The highly creative, knowledgeable repurposing and reclaiming of discarded technology through hardware hacking, software development, research, community building, direct action, resource and skill sharing are well beyond lifestyle changes and do not represent an escape from, or a new frontier of, society, like the back-to-the-land movement, but provide communities with choice and agency. Permacomputing challenges dominant definitions of technology by breaking the sorting spell that dismisses existing and past practices as regressive, a denormalisation of the wasteful and toxic Silicon Valley rhetoric of progress and innovation.

Where permacomputing is starting to make space for issues of class, ethnicity, gender and disability (which is already a leap forward compared to soft technology and Appropriate Technology) practices around feminist servers centre these. The next chapter will discuss intersectional feminist practices that originated in activism wanting to address these issues, where environmental concerns only came in later, or not at all. My intuition at the start of this research project was that the political and ethical choices informing the practice of the communities around feminist servers translate very well to more environmentally sound computing. Issues of gender, intersectionality and inclusivity, asking who is served and who is harmed and excluded create a similar resistance to, and denormalisation of, certain norms proposed by Big Tech. This is exactly the kind of resistance that shakes and destabilises prevailing definitions of technology. To find out if my intuitions were correct, I joined the project *A Traversal Network of Feminist*

Servers, a collaboration between six European communities that wanted to take time to exchange ideas, skills, and knowledge about intersectional, feminist, ecological servers. What can be learned from these small scale technical practices aiming at doing (network) technology otherwise? In the next chapter I'll discuss feminist projects of redefinition through connected struggles.

Chapter 4

Ecofeminist servers

While I was gathering and tracing the origins of terms for the Damaged Earth Catalog, it struck me that the naming of things... is a very male-dominated space.[1] *Conversations about technology, also those in relation to the environment, happened in the terms of a rather homogeneous demographic. However beautiful the wording, the lack of diversity was painful. When artist Wendy Van Wynsberghe tagged me in a message on Mastodon about a call for proposals, I decided to join what would later become the project A Traversal Network Of Feminist Servers (2022), to find out what the practices around feminist servers have to say about technology's role in the climate crisis and to find out if there is such a thing as an ecofeminist server. I spoke to people from the six participating organisations—hypha (RO), Feminist Hack Meetings (GR), esc medien kunst labor (AT), Varia (NL), Constant (BE) and LURK (NL/UK)—with this focus, picking up on different threads that were woven through the project. Towards the end, I asked each community to suggest a term that could reflect their practice. Not as an act of territoriality, of coining a word, but as an attempt to deterritorialise the language around sustainability and IT, to speak about it in our own words. This attention to language and wordings was a recurring theme throughout the project, a (re)claiming of space by (re)naming, speaking in and on our own terms with each other when logged on rosa, the server we used to implement, test and document our ideas. While writing this chapter, I realised that representing the conversations we had perfectly is impossible, so I tried to find my balance on the thin line between 'you had to be there' and quoting people*

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[1] I must admit, I had just watched *Douglas* by Hannah Gadsby and felt particularly inspired.

word for word. However tempting it was to synthesise a definition of a feminist server out of all the conversations that took place, artists and researchers Alice Strete, and Cristina Cochior pointed out there isn't one (Cochior et al.*, 2022). What I did find, is a colourful patchwork of redefinitions of technology in practice.*

Introduction

This chapter pushes back at the male-dominated space of technology and for lack of fitting vocabulary, coins 6 new words to hold space for important practices that are often so everyday and low key, nobody thought to name them. Based on interviews with practitioners from six different European communities, this chapter demonstrates that trans*feminist approaches to tech have a long tradition of challenging dominant definitions of technology, a parallel history that didn't make the canon.[2]

In the first section I introduce the project *A Traversal Network of Feminist Servers* (ATNOFS), its motivations, methods and outcome. I discuss the lack of diversity in the practices I had gathered at that moment and the value of including practises which address what was missing in most of the terms I had encountered thus far: attention to trans*feminist, decolonial, LGBTQIA+ and disability justice struggles, which have a lot in common with climate justice, something argued by ecofeminists.[3] I outline my method of describing each community separately, to avoid generalising about the practices and to do justice to their diversity stemming from situated approaches to technology. The section closes with a discussion of my choice to invite each community to choose their own term to describe their practice, to be able to discuss the topic in and on our own terms.

The second section introduces the six organisations that participated in *ATNOFS*, their practices and how each relates their practice to environmental issues. This section takes the shape of a part of the *Damaged Earth Catalog*, with six entries based on interviews with members of each organisation. Each entry describes the ways in which trans*feminist and environmental concerns intersect in everyday praxis: ecofeminist and always unfinished space making, i diakomistis, jenga computing, patchwork computing, a seismography of artistic practices and with / in limits.

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[2] I use the word trans*feminist to indicate an intersectional, trans-inclusive feminism decentering white cisgender women.

[3] In this chapter I draw on ecofeminism rather than feminist new materialism. Even though both reject anthropocentrism and place the human and non-human on equal footing, ecofeminism focuses on structural oppressions and how these affect both the human and the non-human. This orientation is more aligned with activism and hands-on practice of communities than new materialism with its emphasis on epistemology and ontology (Casselot, 2016). For an in-depth discussion of the tensions between activism and feminist new materialist relationality theory, see *What Comes After Entanglement? Activism, Anthropocentrism, and an Ethics of Exclusion* by Eva Haifa Giraud (2019).

The last section looks into what these practices have inherited from the past and ways in which they challenge dominant definitions of tech. These practices build upon a different history, one that has always centred (different) marginalised voices and resisted the patriarchal power structures reinforced by technology. I discuss the complex history of ecofeminism and feminist technological praxis. Current day practices maintain a strong focus on social and community needs over tools, linking strategic politics with prefigurative politics through examining how inequality is reproduced at different scales. Although each practice is unique, what they have in common is resisting Big Tech in everyday practices and because they do not aim to extract value from users and environment, this translates to inherently environmentally more sound infrastructures.

A Traversal Network of Feminist Servers

This chapter was born on rosa, a small yet significant feminist server that travelled to six communities in different European cities in 2022, as part of the project *A Traversal Network of Feminist Servers* (ATNOFS),[4] ATNOFS was a collaboration between several communities that wished to take time to exchange ideas, skills, and knowledge about intersectional, feminist, ecological servers, with the goal of creating a long-term collaboration framework together with a network of people interested in self-hosting and federated practices that follow feminist, intersectional principles. The project was a reaction to the growing unease with the increased reliance on the media oligopoly of Microsoft, Google and Zoom for communication during the lockdown phase of the COVID-19 pandemic; a reliance that is now completely entrenched and normalised (Van Wynsberghe

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[4] I owe this chapter to the generosity of: Sergiu Nisioi and Anca Bucur of hypha, Mara Karagianni, Artemis Gryllaki and Aggeliki Diakrousi of Feminist Hack Meetings, Roel Roscam Abbing, Lídia Pereira and Aymeric Mansoux of LURK, Cristina Cochior, Alice Strete, Manetta Berends, amy pickles, and Julia Bande of Varia, Reni Hofmüller and Nina Botthof of esc medien kunst labor and Wendy Van Wynsberghe, Élodie Mugrefya, and Martino Morandi of Constant. Thank you all for the wonderful conversations and good company.

et al., 2022). All six collectives shared a wish for cultural and political expression outside the monitoring of employees and users via obscure, bureaucratic algorithms, and advertising monetisation. During the year, six physical meetings were held, called 'chapters', which were documented on the server rosa.

Each chapter engaged with the overarching question of community and sovereignty in relation to network services, data storage and computational infrastructures, but approached it in a situated way. Each chapter proposed a two day programme with a focus on topics that were urgent in their specific context. Through a collective experimenting, developing and working with the tools and methods of each chapter, the different groups each shared knowledge and skills from within their context, and received support from the visiting groups. Each chapter aimed to share the outcomes of this exchange within their local community. *ATNOFS* took place in Rotterdam, Bucharest, Graz, Athens and Brussels.[5] Its main protagonist, the server rosa, was a tool for documentation but also a social space. They hopped on and off trains, and one time even travelled by mail, disappearing from the network only to reappear again shortly after, anxiously awaited by us, a group of users experiencing (sometimes uneasily) the *Feminist Server Manifesto*'s last statement: a feminist server "tries hard not to apologise when she is sometimes not available" (Reiter *et al.*, 2014).[6]

The name rosa was picked by artist Alina Lupu as an homage to Rosa Parks and Rosa Luxemburg, and was thought of as multiplicity and therefore referred to with a lowercase r: a rosa not the Rosa.[7] From the start, rosa was conceived of as anything but a standard server. Rather than a virtual private server somewhere in a data centre, set up with a standard operating system, reachable from anywhere at all times, rosa is a small physical machine that travelled with us and hosted an increasingly customised version of Linux. It was a travelling infrastructure set up for the specific tasks of documentation, collective note taking, and publishing: a web-to-print ecosystem of custom open source tools, created by Varia, used to turn the generated documentation into one final publication (Van Wynsberghe *et al.*, 2022).[8] Besides being the documentation tool of the project, rosa also acted as an object of study, helping us to think through what a feminist server is and which feminist principles are important to the different communities. By sharing this digital space and negotiating how we wanted to be there, together, rosa "became a moving repository of reflections on the norms and rigidities that computing enacts, which sparked ways to practically counter them." (Van Wynsberghe *et al.*, 2022, p. 5) It led to a rethinking of the language around servers and computing and what was enacted through it.

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[5] The project was funded by the *Culture of Solidarity Fund* by the European Cultural Foundation, which meant that the participating organisations needed to be based in the EU. The organisations around the project were very aware that this limited the perspectives on the questions raised to their specific contexts but hoped the project would be taken into other places, where it could be filled with different words, questions and urgencies (Van Wynsberghe *et al.*, 2022).

[6] This anthropomorphising of rosa is reflective of the role the server played throughout the project. Instead of treating rosa as a lifeless object, easily replaceable and disposable, they were cared for as an object embodying the ATNOFS community, the many hours of work from many people, that which enabled our collaboration and held the written, drawn and photographed traces of our work. They are a "polymorphous non-binary assemblage" that represents "a community of practice, a complex materiality, and a genealogy of intersected struggles and conditions of oppression and privilege" (Van Wynsberghe *et al.*, 2022, p. 7; Trans feminist servers, 2024)

[7] Rosa Luxemburg and Rosa Parks were invoked as bringing in historical context, a "herstory of resistance" (Van Wynsberghe *et al.*, 2022, p. 10).

Why did I join ATNOFS, besides being tagged in the Mastodon message by Van Wynsberghe which sparked the project? I was aware that the terms I had gathered thus far represented a rather homogeneous demographic of cis white men. An initial overview of historical and contemporary terms I had made, which later turned into a paper for the *Computing within Limits* workshop, reflected this lack of diversity. An alternative history of computing started looking too much like the standard one. The commitment to a pluriversal approach, gathering a diversity of definitions of technology in the climate crisis, meant hearing different voices from different contexts.[9] Next to that, it was exactly this focus on diversity which was lacking within each of the terms already gathered, which were strongly centred on environmental issues but didn't address feminist, decolonial, LGBTQIA+ and disability justice struggles. I broadened the scope of my research by not only looking at specific terms I encountered but also at practices lacking a name and which weren't commonly associated with environmental concerns.

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[8] The publication contains contributions by Wendy Van Wynsberghe, Vlad Dobrițoiu, Teo Săvoiu, Spideralex, Sergiu Nisioi, Roel Roscam Abbing, Reni Hofmüller, ooooo, Nina Botthof, Martino Morandi, Marloes de Valk, Mara Karagianni, Manetta Berends, Lídia Pereira, Julia Bande, Femke Snelting, Élodie Mugrefya, Donatella Portoghese, Danae Tapia, Cristina Cochior, Azahara Cerezo, Aymeric Mansoux, Artemis Gryllaki, Aggeliki Diakrousi, Anca Bucur, amy pickles, Alice Strete and Alex Ștefănescu.

[9] The diversity of contexts discussed within this dissertation is limited by the scope of this research project, which is a selection of communities of practice in the EU and US. As explained in the introduction, the cause of the problem this study engages with lies in the Global North, and this is also where the change of perspective on technology required to do something about it needs to take place, where an exploration of redefinitions of technology will be most productive.

By joining ATNOFS, I could explore, even though there was a lack of explicit attention to environmental issues within the practices around feminist servers, how the different practices of the participating organisations were redefining technology without having coined a name for it, and whether they had environmental repercussions. These practices challenge hegemonic conceptions of computing and negotiate technology's impact and role in the climate crisis, even though the language around feminist servers hasn't focused attention on this aspect of the practices. I decided to join ATNOFS to participate in the chapters and to interview each participating organisation, asking practitioners about their views on the relation between their practice and the environmental impact of technology. I learned in this process that feminist servers, as objects of a collective re-imagining of IT, intentionally and unintentionally bring intersectional feminist and environmental concerns into relation. This practice has a different history than that of other terms I discussed, one rooted in feminist activism as well as ecofeminist and feminist STS theory.[10]

Diversity and situatedness

This chapter is based on a different research method than the previous two. It is not based on an inquiry into a discourse through published sources, nor a reflection on a practice as a participant-observer in a community. I am familiar with each of the organisations, and have collaborated with most of them in the past, I am however not part of them. To gain in depth insight into the views present at each participating organisation, and into how ATNOFS itself has developed, I followed the project by participating in four chapters (Varia, LURK, esc mkl and Constant) and by interviewing two to three members of each of the six communities. To situate myself as a researcher within the project, I aimed to build upon Stenger's concept of collective apprenticeship and the art of creating 'suspense' (Stengers, 2017). Instead of conducting research isolated from messy reality, which concludes with a 'and therefore', I wanted to learn with others from a situated perspective, and to conclude with a successfully established relation without knowing what that may lead to, in other words: suspense. To further build on this collective apprenticeship, I picked up on Graeber's suggestion in *Fragments of an Anarchist Anthropology*, in aiming to:

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[10] I will discuss the history of feminist server practises and related theory in the last section of this chapter, but an in depth discussion is outside of the scope of this dissertation. For further reading please see the work of Femke Snelting (2015), Shusha Niederberger (2019), Spideralex (2018) and Sophie Toupin (2018).

> "[...] look at those who are creating viable alternatives, try to figure out what might be the larger implications of what they are (already) doing, and then offer those ideas back, not as prescriptions, but as contributions, possibilities—as gifts." (Graeber, 2004, p. 12)

My involvement in the chapters was that of an active participant, like all who were present, contributing to the chapter's workshops, discussions and note taking. Next to that, I organised the interviews in two steps. First I had an unrecorded, brief and exploratory conversation with each organisation; introducing my intentions and finding out which aspects of an organisation's work could lead to a more in-depth discussion. The second part was a recorded semi-structured interview, where I posed follow-up questions based on the topics identified in the first talk. Through these two paths, I gained a deeper understanding of how each organisation envisions the relations between their infrastructure, community and the environment. Collective apprenticeship, as opposed to competitive and extractivist research, informed my choice to tune in as a fellow practitioner and to publish the result of my involvement as part of the *ATNOFS* publication (Van Wynsberghe *et al.*, 2022).

Rather than flattening each organisation's insights into one general description relating feminist server practices to environmentalism, I decided to stay as close as possible to the conversations I had with the participants, creating one section per group. In each section, I recount the parts of the interview that went towards answering what we learn from feminist servers about redefining technology in relation to the climate crisis. I will reflect on and contextualise the different practices in the final section of this chapter, not within the subsections themselves.

Instead of using one umbrella term such as feminist technology, I decided on a different approach. An umbrella term wouldn't do justice to the diversity and specificity of each organisation's methods and views. I was faced with one problem however, beyond 'feminist' none of them used a specific word or term to describe their take on tech. The careful attention to language throughout the ATNOFS project, inspired by feminist linguistic activism, led me to ask each community to suggest a term that could reflect their practice. Not to give a static definition, nor as an act of territoriality, of coining a word, but as an attempt to deterritorialise the language around sustainability and IT. It doesn't go towards establishing my thesis, it also doesn't disprove that new terms have arisen giving voice and shape to different definitions and roles for technology on a damaged earth. I openly manufactured evidence, rendering it useless for that purpose. It was an act of space making. Thinking of words which describe practices that may seem so common, nobody thought to name them. This allowed us to speak about technology in our own words, on our own terms and to (re)claim space for collective, feminist practices alongside more easily identifiable practices with names, coined and forever traceable to one (often male) author.

This naming wasn't done in the spirit of a "utopics of radical resignification", as philosopher and gender studies scholar Judith Butler has called the belief in the liberatory power of renaming things (Butler, 1993, p. 224). Butler argues that the reach of a performative speech act isn't controlled by the writer or speaker because they do not own them. Discourse has a history which precedes and conditions its contemporary usages: "[n]either power nor discourse are rendered anew at every moment" (Butler, 1993, p. 224). This is where Butler and Williams' thought on language and power align. Williams however, focuses on the inquiry in this ongoing historical development of meaning, in order to understand how our 'consensus reality' emerged, to be able to imagine how it might be changed (Williams, 1976; Fritsch, O'Connor and Thompson, 2016). Butler on the other hand, places strong emphasis on the importance of performativity as political contestation of contemporary relations of power, even though this means "being implicated in that which one opposes" (Butler, 1993, p. 241).[11] My invitation to name was not done in the conviction that words produce reality, or limit people's thought, but as a sign of intent, one that can guide our imagination towards the possible. The following sections are the result of this gesture, and of the many conversations I had with those who have logged in and out of rosa in 2022.

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[11] Butler discusses performative speech as part of a discursive production of identity, specifically gender identity. Not through single speech acts, but through a process of reiterative contestation of heteronormativity, which itself is based on a historicity of norms and related discourse that function as a type of regulatory power. This discourse materialises bodies but is not fully stable, and always relies on an 'othering', an 'outside' to the masculine and feminine binary (Butler, 1993, p. 188). For an exploration of how this historicity of norms and reiteration of the probable, to the exclusion of others, intersects with technology, please see *Volumetric Regimes: material cultures of quantified presence* (Rocha and Snelting, 2022).

Ecofeminist and always unfinished space making

Based on two conversations with Sergiu Nisioi and Anca Bucur of hypha. (Nisioi and Bucur, 2022)

Hypha (RO) is a collective based in Bucharest, Romania. Together, its members work towards a better understanding of technology and its deep-seated implication in our socio-political climate. With a filamentous metaphor as its name and guiding imaginary, hypha identifies with the long and branching underground growth, interconnecting different entities with a soft, diverse and non-hierarchical sociology. They view their collective as an unfinished project, a story that is being written. The people taking part in hypha meetings are a heterogeneous group, joined by the curiosity to critically and enthusiastically explore technology: filaret16, an anarchist DIY space, Cutra, a radical queer feminist magazine, Frontul Comun pentru Dreptul la Locuire (Housing Rights Common Front), an activist group which is part of the housing rights movement, Pagini Libere (Free Pages), an anarchist, autonomous editorial collective and Colectiva Literatură și Feminism, a literature and feminism collective promoting feminist and queer literature. Their meetings are informal and focus on subjects emerging naturally from their lived experience. Each member has a different understanding and relationship with technology, which results in diverse opinions coming together. They have held space for their differences, and they have held each other through learning about the things that they struggled with (Stefanescu, Bucur and Nisioi, 2023).

The first thing that surfaced during my discussions with hypha was a confrontation with the paradox of sustainable and feminist ICT. hypha acknowledges that network technologies are deeply patriarchal and have a patriarchal history that continues to spread unequally in the world. Similarly, the extractive and polluting production, use and disposal methods of digital technology keep accelerating, affecting the economic peripheries hardest. True autonomy and environmental sustainability are unachievable in this context, you are always enmeshed in patriarchal, capitalist, and unsustainable systems, so the only thing you can do is to make do with what you have, with what is already there. This acknowledgement doesn't mean surrendering, but functions as a catalyst for doing technology otherwise, for possible ongoingness.

For hypha the practices developed around rosa made it clear that rosa is a feminist server not because of any specific technology or tool, but because of how we engaged with each other, how rosa gave us a common space. This common space was rooted in feminist ways of thinking and theorising about the world. This involves the idea of care—to have something together that we—the people around rosa—can take care of.[12] In doing this, we create occasions to reinforce our community, to know each other better, to know about the space and how to use it. Examples of this care include paying attention to issues around consent and understanding what we are each comfortable giving and receiving. It's like a house: what's important is how we're collectively deciding to live in it, not the house itself. Because of this, hypha didn't want to focus their chapter on providing technical knowledge to others to self host, but on hanging out together, learning to share this space, and figuring out how we want to use it. It's a space to collectively take care of; we're not focusing on the tech but on the community it gives space to.

This space-making is always unfinished and ongoing. In hypha's context there is no funding, which means that such an endeavour can only be carried forward by a collective of volunteers with little time on their hands. It's a financial problem.[13] Continuity relies on a very delicate balance of giving and taking. The risk of tasks becoming too heavy a burden is high, and with this the risk of irritations and conflict. Setting up any kind of technological infrastructure cannot fall on the shoulders of one person and requires a gradual process of consolidation in a heterogeneous group bringing together different backgrounds and types of knowledge. It's an ongoing process of learning from each other. It can only converge in a local and specific way. hypha doesn't intend to copy practices from elsewhere and cannot afford to.

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[12] I use the word 'care' with caution, it means radically different things in different contexts. Here it indicates the effort of the group to ensure rosa is fulfilling their role well, meaning the server 'works' and that this shared space meets the social as well as practical needs of the group. For a discussion of the contested meaning of the word 'care', see Christine Kelly's (2016) entry *Care* in *Keywords for Radicals*.

[13] It could be argued that operating outside a corporate or institutional setting brings great freedom, and that this benefit outweighs the costs, yet this freedom comes at the price of having to do the work in spare time, next to paid labour. The amount of spare time available to individuals greatly depends on their socio-economic situation and the amount of funding available to facilitate this work greatly depends on which country a community is located. For hypha this clearly presents them with difficulties.

> "While urging for depriving the technological apparatus of its classist and gendered strains and vocabularies, hypha stands for a knowledge situated in collective emancipation. It intends to carry workshops and lectures, taking on new-materialist, eco-feminist, hacktivist possibilities of software actualizations and embodiments." (Bucur and Nisioi, 2022)

This brings me to ecofeminism, which has always linked feminism with environmentalism and decoloniality, without prioritising one over the others but showing how they are interrelated (Salleh, 1997). hypha's space-making is informed by ecofeminist and decolonial thought. This means not copying technology and practices or borrowing language from the West. Technology and practices which are assumed to be universal and scale to a global level, disregarding diversity and local contexts, and which are based on digital extractivism. Instead, hypha see their practice as a reconfiguring of scale, thinking through digital spaces in a situated and local way, important in disseminating and sharing knowledge. They are in the process of learning about setting up and maintaining online shared spaces with queer and marginalised groups, with a decolonial way of doing.

During their chapter, hypha identified the needs of the community of local collectives surrounding them. Their main concern is security, a safeguarding from state or corporate monitoring as well as from potential (cyber) attacks and harassment. This has become more urgent since the COVID-19 pandemic and the war in Ukraine, resulting in a further militarisation of the state. The collectives also wish for a self-hosted archive, documenting their events, protests and actions so they have ownership over their histories. Although they want alternatives to corporate social media, they depend on Facebook for communication because of its widespread adoption in Romania. There is a wish for digital emancipation however, but they note that access to such technological emancipation is limited by class and social context, so a trade-off is required if they want to keep doing their work. They aim to start small and support local groups with meetings in which they share technical knowledge and create a local vocabulary to discuss technology from a critical, situated perspective.

Perhaps, hypha mused, the only way to go about things locally is to stay on a local area network (LAN) and only much later connect multiple local networks together.

Η Διακομιστής (I diakomistis)

Based on two conversations with Mara Karagianni, Artemis Gryllaki, and Aggeliki Diakrousi of Feminist Hack Meetings (Karagianni, Gryllaki and Diakrousi, 2022).

Feminist Hack Meetings (FHM) is a project initiated in 2020, in Varia, Rotterdam, that aims to create a safe space to explore the suggestions, urgencies, and potentials of feminist hack and tech initiatives. FHM has no physical space and hovers between Rotterdam and Athens. They organise events around alternative social media and technology from a feminist perspective, which is important in the Greek local arts and activist context. The feminist and #MeToo movements, responsible for introducing the word femicide in legal and social contexts, to draw attention to violence against women, have gained momentum in Greece. However, since most local collectives rely on Facebook and Instagram for organising and communication, they are vulnerable to online harassment and censorship. FHM organises research meetings and workshops around technology and feminism, enabling diverse activities such as socio-political discussions, prototyping, skill sharing, and experimenting with various artistic practices. Feminist pedagogies, and Free/Libre and Open Source Software (FLOSS) inspired ideas of sharing, inspire their working methods. Their sessions are open to people who envision the making of technology, and its processes, as a feminist practice.

When I asked FHM about their infrastructure and their ways of thinking through its ecological impact I was confronted with some assumptions I had to get rid off. FHM doesn't have an infrastructure, and even if it did, it doesn't have a space to put that infrastructure in. Even if it had a space, they haven't had time to think about the environmental impact of their work because they have been struggling to find time to focus on something that is more urgent in their context: making space, in Athens, for feminist ways of understanding tech literacy. Local feminist groups are mostly focused on community building in which technology doesn't play an important role. Local hackerspaces haven't been open to feminist practices. FHM received hostile reactions to the language they used; for instance calling a server 'feminist' and their translation of the word 'server' into Greek, η διακομιστής, with one part of the word gendered female and the other male. This is unorthodox but meaningful to FHM because in Greek the female version of a word sounds smaller or less significant than the male, less valued or valuable. They wanted to challenge the associations of gendered language and of gender and technology. Someone from a local hackerspace accused them of violating the language. There were many similar anecdotes. They had not expected such hostile responses to their work.

FHM puts a lot of care into translation. They want to break with the idea that IT is only for experts, that it is hard. For non-native English speakers, the jargon involved in server administration can be an obstacle to learning new skills, therefore, during the FHM chapter in Athens, all presentations were in Greek, which were live-translated into English. The workshops were in English but with a live Greek translation. This greatly improved accessibility and, because the live translations slowed down the pace of things with regular pauses, the audience had more time to process what was being said. It gave people time to reflect. This was a very positive experience. There was a lack of infrastructure though. Because the space didn't have a proper mixer, the streaming was very complex, seamful like patchwork computing, but taking a toll on human time and energy. There was no Wi-Fi at that moment, so they had to use three phone hotspots to provide their network connections. This became such a complex situation that at one point they accidentally, only very briefly, streamed both languages simultaneously. Someone listening said it was kind of beautiful.

This attention to, and subversion of, language was given presence during the first day of the FHM chapter. The project *WordMord* was presented and discussed. WordMord, a combination of 'word' and 'mord', which means murder in German, to the makers means words can kill.[14] The project explores the ways in which language and technology intertwine with trauma and violence but also with the body, pleasure and sexuality (Van Wynsberghe *et al.*, 2022). It started as a performative reading during an event and grew into an ongoing exploration of poetic, embodied and algorithmic tools, and methods which destabilise hegemonic and violent aspects of language, a type of linguistic activism. One of their works is *No Annotation Is Alone*, which intervenes in the legal discourse, by annotating a chapter of the Greek criminal code concerning crimes against life. They created a tool through which they could change the wordings, for instance replacing homocide with femicide, also allowing visitors to annotate and change the text.[15]

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[14] WordMord is a project by Aggeliki Diakrousi, Christina Karagianni, Stylianos Benetos aka Oýto Arognos, Vassiliea Stylianidou aka Franck-Lee Alli-Tis and the group Mounologies: Eleni Diamantouli and Anna Delimpasi, and later in collaboration with Cristina Cochior and Manetta Berends. A detailed discussion of the project can be found in *A Traversal Network of Feminist Servers* (Van Wynsberghe *et al.*, 2022).

Networks of care and trust

There is so much work to do; ecological considerations are not the top priority. How can you rethink your network infrastructure in environmental ways if you don't have any infrastructure to begin with? The work is done under difficult circumstances and this is a heavy burden to carry for all those involved. Yet FHM cultivates a valuable and inspiring way of working within limits. They are a lightweight organisation, they are nomadic and, for lack of their own infrastructure, share resources with other organisations. This has resulted in FHM being embedded in a network of care and trust with a long history in feminist tech skill-sharing.[16] They are connected to systerserver, which "offers services to its network of feminist, queer and antipatriarchal folks."(systerserver, 2023) Systerserver was launched early 2005 by Genderchangers, "a group of women and women-identified gender minorities, started at the ASCII hacklab around 1999" (Barok, 2022), who:

> "focus on free and open source software as a political decision. We share our technical skills in the same spirit. In this way, DIY expands into DIT: Do It Together. Things can break and it's fun!" (Genderchangers, 2009)

Genderchangers started the Eclectic Tech Carnival (/ETC) in 2002, "a gathering of feminists who critically explore and develop everyday skills and information technologies in the context of free software and open hardware."(/ETC, 2021) /ETC was hosted in Athens in 2019, which is when the idea for FHM took shape. Through systerserver they are connected to mur.at, a grassroots art server farm in Graz where we took server-selfies during the esc mkl chapter. Two members of FHM are part of Varia and they are connected to Constant through, for instance, the sharing of their Big Blue Button video conferencing platform.[17] This network is thoroughly connected to many people participating in ATNOFS and beyond. So FHM asks: why would we need a server anyway? This network of care and trust is exactly what they are trying to continue, feed, and expand.

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[15] *No Annotation Is Alone* emphasises the erasing of extreme violence against women through insisting there needs to be a name for it, a category within the criminal code to bring the existence of this violence to light. Again the work of Butler is important because it unpacks the urgency and meaning of such contestations and how language can be violent through exclusions and erasure (Butler, 1993).

[16] Although Karagianni, Gryllaki and Diakrousi were not aware of Dekker's concept of networks of care, their way of embedding themselves in networks of care and trust through reciprocal involvement with other organisations, can be seen as a related concept; in this case applying to a collective rather than a work of (net)art (Dekker, 2022). A distinguishing aspect of FHM's practice is the mutual support given through feminist practices of skill sharing.

Jenga computing

Based on two conversations with Roel Roscam Abbing, Lídia Pereira, and Aymeric Mansoux of LURK (Pereira, Roscam Abbing and Mansoux, 2022).

LURK started out as a small collective of artists/hackers, cultural workers, sound and design practitioners, from makers to writers, interested in facilitating and archiving discussions around net- and computational culture and politics, proto- and post-free culture practices, experimental, sound, new media, software art, and related topics. They have been active since 2014, and today they are best described as both a collective and a community of communities. Practically speaking, they offer like-minded people and peers the possibility to host their email discussion lists, have access to instant messaging services, participate on alternative social media platforms, as well as to make use of an audio and video streaming server for events, internet radio broadcasts, and miscellaneous experiments.

LURK mostly works on their servers and services with very little time and, up until very recently, no budget so, "everything is working on scraps, DIY, and tons of tons of gaffer tape." (Pereira, Roscam Abbing and Mansoux, 2022) One of the servers that was running the mailing list used to be just hack on top of hack to keep it running. It only started to look properly administered quite recently. I don't think anyone in the LURK community notices, but from the administrator point of view, it feels like one of those super-fragile games where it's all in a very fine balance… touch one wrong piece and it all collapses:

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[17] Big Blue Button is an open source virtual classroom video conferencing platform.

Jenga Computing. The word 'jenga' is derived from the Swahili word—'kujenga'— to build, but for LURK, Jenga refers to a fragile balance. It relates to the diagram they made for their chapter's workshop. It was called *precipice workflow*. There is a logic behind what they do, but they are constantly trying to make room for something that takes time and is complicated, yet often situations force them to act quickly.

Building things from scraps and making do with what they can find made them think of a 2020 Mastodon toot by Diana Thayer about a future with two major camps of techno-radicals: librists and junkers. The description of the junkers especially resonated with LURK.

> "librists—actually, libre-ists—believe in ethical works from the ground up. they operate far-flung rare earth repositories and small-scale manufacturies which produce artisanal computers. wood finish, decent transistor count, moddable, open source. in many ways: the dream of open hardware.
>
> Junkers take what exists. the logistics of producing electronics are slow at best and critically unreliable the rest of the time, so junkers repair machines left by the capitalists, it's shit tech made shittier by age, but there's plenty of it so at least you never run out of spares.
>
> 'That's comcast tech,' a librist says with disgust.
>
> 'Zero net waste op,' the junker replies dismissively." (Thayer, 2020)

Making do

LURK's Mastodon instance requires a more powerful machine, for which LURK is supported by Greenhost,[18] but for their back-up server and server Agnes, which is running XMPP,[19] the mailing list, and mumble,[20] they reuse old hardware. Even though this initially wasn't driven by an ecological motive, it results in a smaller footprint. The production of hardware is responsible for most of the resource use and energy consumption in a device's lifecycle, meaning that most energy is already consumed before a device is turned on for the first time (Pickstone, 2021). Being frugal with energy is of course a good idea, but it can never compensate for the energy used during a device's production; buying a more efficient machine is not a solution (unless it concerns a device that uses more energy during its use-phase than during its production, such as a kettle). Next to that, working with older hardware means working within limits. Especially on server Agnes, everything needs to be lean because it doesn't have a lot of power. They don't use virtualisation, for instance, because it uses too many resources. Not optimising is not acceptable. They've always considered that as simple ethics—not doing it would be wasteful.

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[18] Greenhost is a Dutch hosting company whose servers are at the Evoswitch data centre in Amsterdam, which runs on wind energy.

[19] XMPP or Extensible Messaging and Presence Protocol is an open communication protocol meant for (among other things) instant messaging. It functions as a federated open system (like email), meaning anyone can run their own server.

[20] Mumble is an open source, cross platform, voice over IP application used mostly by gamers.

LURK traces the ethics of anti-wastefulness back to practices from 25 years ago. At that time hacker communities repurposed old machines and discarded hardware by putting the operating system Linux on it. A lot of places, like Access Space[21] in Sheffield and Amsterdam Subversive Center for Information Interchange (ASCII),[22] were using this approach. At that time it was more anti-consumerism than environmental activism: giving a second life to these things and giving them to people who couldn't afford a new machine. Things have changed a lot since then though; old machines are still fine for low level tasks, but crapware such as bloated websites, video conferencing tools, and office suites ruin this potential for the average user. For servers it can still work, depending on what types of services you are running. Our conversation paused briefly, then LURK's junker ethos was expressed thus:

> "We are not forecasting about collapse, we are not environmentally friendly by design, we are mirroring the shit we are in. We're trying to make do with bits and pieces." (Pereira, Roscam Abbing and Mansoux, 2022)

They don't profile themselves as a feminist server, but the way they approach the Code of Conduct (CoC) and Terms of Service (ToS) of their Mastodon instance as living documents that need to be performed is clearly rooted in feminist practice. These texts are constantly updated based on what the moderators experience. LURK is attentive to how these documents work in two directions, relying on users flagging problems to moderators, as well as relying on the wordings of their CoC and ToS, making users feel either encouraged or discouraged to report certain things to the moderators, especially things that are hard to describe in a set of rules: micro-aggressions such as being made to feel invisible, regularly being corrected on details, or subtle subtoots which are only recognisable as such by the one targeted.[23] LURK wants to pay attention to this intangible unease you can experience in online social spaces, so people feel more legitimised to mention it to the moderators.

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[21] Access Space is a digital art lab in Sheffield (UK) which promotes sustainability, as well as access to digital tools for those living in poverty, through the reuse of old hardware and revamping it with FLOSS. A description of *Redundant Technology*, which originated in Access Space, can be found in the *Damaged Earth Catalog* (see portfolio).

[22] The Amsterdam Subversive Center for Information Interchange (ASCII) was a squatted communication lab in Amsterdam, which promoted FLOSS and building computers from scavenged parts. ASCII moved to different squats until it closed permanently after an eviction in 2006.

LURK started experimenting with a model for financial sustainability of their services through voluntary donations by users via Open Collective,[24] a legal and financial toolbox for grassroots groups. They try to test and create a precedent that can hopefully help normalise paying for services that commercial actors are able to offer for free because of their business models based on user surveillance, targeted advertisement, and data brokering. LURK's funds support labor instead of hardware and are visibilising normally invisible labour to help improve things "one jenga block at a time" (Pereira, Roscam Abbing and Mansoux, 2022). LURK succeeded in receiving trust from a group of people who feel at home on their servers. They don't consider themselves a shelter but do believe there is something happening, something consistent; people tend to stick around.

Patchwork computing

This description is based on two discussions I had with Cristina Cochior, Alice Strete, Manetta Berends, amy pickles, and Julia Bande of Varia (Cochior *et al.*, 2022).

Varia is a Rotterdam space developing collective approaches to everyday technology. Its members are active in the fields of art and cultural production. Varia maintains and facilitates a collective, FLOSS-based infrastructure supporting their work. Their focus on everyday technologies stems from the conviction that technology shouldn't be the exclusive domain of specialists. It affects everyone and should enable, rather than preclude, diverse ways of living. This means keeping in mind the multiple and entangled perspectives and needs of people when working with a technical object. Focusing on everyday technology means questioning the hierarchies in place within technical objects and therefore the valorisation of skills needed to design or use these objects. The sewing machine is no less important than the laptop. This means reconsidering the hegemony of high tech: cheap, artisanal solutions are their method of choice (Van Wynsberghe *et al.*, 2022).

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[23] A post on Mastodon is called a toot. A subtoot is, just like a subtweet on the platform formerly known as Twitter, an often negative or insulting comment about another user without mentioning their handle, so that the post doesn't show up in the targeted user's notifications.

[24] LURK's Open Collective page shows how users can contribute, who contributed, the income, expenses and current balance. Open Collective is a platform that offers services to help raise and transparently manage funds as a group and can act as a fiscal host.

Varia prepared rosa before the start of the project, during a series of Thursday evening get-togethers. During these meetings a lot of thought was given to what functionality would be needed, a careful selection of tools to accommodate ways of working together. It was clear that this wouldn't be a simple install party. Rosa would not start from scratch, nothing ever does, but instead would be built using a patchwork of projects, scripts, and tools originating from Varia, XPUB,[25] Open Source Publishing,[26] Constant and the wider networks they are part of. This method made a point of showing the seams by not automating everything. This mattered because it made everyone more aware of all the moving parts. This seamful patching together of small tools, adapting them to a specific context to allow for meaningful engagement, is patchwork computing.

Varia approached rosa as a tool for documentation but also as a social space. The role language played in server interactions was a very concrete translation of caring for and claiming that space. Because for some Varia members it was the first time using a terminal, while others already had experience, the language was something that they could all engage with. Varia recalls the language of the fresh Linux install was bringing a certain hostility to the environment. This started with the 'lecture file' that popped up after running the sudo command for the first time.[27] The severe tone of the text felt out of proportion to the situation; they had only just finished dinner, they were having a nice chat, and out of nowhere, they got lectured. "Suddenly this other voice comes in that is taking over the space from a place we didn't know was even there." (Cochior *et al.*, 2022) Changing certain texts, such as the sudo lecture file, renaming commands and tweaking welcome messages, was a way of making it more comfortable to move around rosa, through small scale interventions. The realisation that you don't have to take these wordings for granted was very inspiring and kept playing a role throughout the project.

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[25] XPUB is the master Experimental Publishing at the Piet Zwart Institute in Rotterdam. XPUB approaches publishing from two angles; as participation in and analysis of the technological, political and cultural contexts in which publishing takes place; and how these are used to create publics.

[26] Open Source Publishing (OSP) is a Brussels based graphic design collective that questions and finds alternatives to the standard graphic design studio model. OSP uses Free/Libre and Open Source tools.

[27] The sudo command allows users, if they have been granted sudoer rights, to execute commands which require system administrator privileges, without having to enter the password of the system administrator.

This reclaiming of the space by making it speak in a voice that was ours (the participants') also happened through other means. One very risky but interesting move was giving everyone root privileges, erasing the power differences between users and administrators. This made room for other ways of doing, for instance, in dealing with errors and error pages. Normally, when someone tries to load a page that doesn't exist, or is served by a service that is currently not running, the server loads an error page, a dead end for the visitor. Because everyone had root, these pages could be rewritten to include instructions on how to fix the problem. There was a conversation about automating this process, for instance restarting etherpad-lite, but it was decided that this was not a desirable thing to do. Automating it makes it invisible, you lose a level of understanding. It's one of the ways the seams of the patchwork are made visible and it transforms moving and replugging the server into a type of ritual: you plug it in, you start it and you manually start the services: "like you make the coffee, open the blinds and you welcome everyone inside." (Cochior *et al.*, 2022)

Even though there wasn't a specific environmental focus in how rosa was prepared, the server ended up quite lean because of its limited computational capacities. At first they were too limited, which meant the donated machine had to be replaced by a second-hand one because etherpad-lite needed a little bit more power when many people were working on documents at the same time. Using second-hand hardware was an environmentally significant choice, making do with what is already there, and also working within the limits of the machine. Varia mentions that working with such a modest device was possible because rosa is thought of mainly as a tool for documentation, allowing for more flexibility, also in terms of availability. Rosa went offline every time they travelled. This adaptation to the context, this situated way of serving, challenges certain paradigms that cause environmental harm, such as expecting 99.999% uptime and expecting servers to have the latest Graphics Processing Unit (GPU) and Central Processing Unit (CPU) no matter what the task at hand is. Certain tasks are essential and require this, but many more services could be approached in this flexible and situated way.

Something Varia intended to do, and something that could help in keeping computationally heavy processes in check, was to monitor all the processes on rosa and make them more visible. They wanted to look at which things take up the most space, and if that space can be justified, to make the space more equal for all the other processes. This idea was triggered by a cron job that was executed very often and started slowing everything on rosa down.[28] Although they didn't have time to work on this visualisation, rosa did gain a voice, even several voices, in Graz. Listening to the server made it more present in the space. Pushing this idea further, the making of space for different processes (computational or other) could mean slowing down a cron job to once a year. We started thinking about seasonal computing, something that doesn't need to happen all year round, but only on one particular moment in time, in one specific location. Could computing be less like a 24/7 supermarket and be more seasonal. As you would go to an orchard to pick fruit once a year, you could go to this space where one special computational task is happening which would be dormant the rest of the time?

Seismography of artistic practices

This description is based on two discussions I had with Reni Hofmüller and an email exchange with Nina Botthof of esc medien kunst labor (Hofmuller and Botthof, 2022).

Esc medien kunst labor (aka esc mkl, or esc) is an art initiative, a cultural organisation, and exhibition space based in the city center of Graz, Austria. While its main task is facilitating the production of art, it also puts emphasis on the observation and documentation of artistic processes. The artistic activities of esc mkl are determined by the understanding of art as a subsystem of social and societal reality. As a hub for the exchange of ideas, esc mkl serves to network between artists, scientists, theorists, and many more, while also providing infrastructure, technical support, and advice. Furthermore, exhibitions contribute to the public awareness of art and promote artists. Esc is a product of the 1990s and started when the Internet seemed, for the briefest moment, an open and unobstructed space without artificial borders or commercial goals, a perfect breeding ground for creativity and the spirit that shaped esc's philosophy. Next to art, feminism has always been a key subject for esc. A central motive was the acquisition and sharing of knowledge for and by FLINTA* people, encouraging independence and self-reliance (Van Wynsberghe *et al.*, 2022).[29]

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[28] A cron job is a scheduled command which will be executed periodically, automating certain recurring maintenance tasks on a Unix-like operating system.

Esc mkl describes its work as a seismograph of artistic practises: it observes and records artistic processes, recognises the creative potential of artists within current technological and socio-political developments, and promotes this work, making it visible to a broader audience and documenting the outcome. In our conversations (and in past encounters), esc has always been active in bridging different worlds, making connections between generations, localities, and contexts, bringing a diversity of people together around shared topics of concern. This seismography is not one that alerts us to impending disaster but to the building up and fostering of momentum within artistic, activist, and feminist practices.

Reni Hofmüller, one of esc's founders, speaks about how she uses resources as an entry point to discussions about technology, as a connecting element that ties labor, time, energy, sustainability, intersectionality, decoloniality, feminism, embodied and situated knowledge together. This means that, even in situations focusing on one specific struggle, we can't forget the others; these struggles are all linked. Hofmüller explains how she tries to have a holistic approach to the things she does, and one way to do that is by connecting it all to resources: resources of her own time and energy, the energy it takes to bring her from Graz to Rotterdam, for instance, the financial resources, and the responsibility towards others that have poured their time and energy into making this project happen. It's a way to understand our surroundings. In each constellation, resources are a big question, infrastructure is a big question. It is important in her work to contextualise what is done and think it through as situated knowledge. I felt this approach resonated a lot with ecofeminist thought, with something activist and scholar

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[29] FLINTA* is a German abbreviation which stands for Frauen, Lesben, intergeschlechtliche, nichtbinäre, trans und agender personen, which translates to women, lesbians, intersex, non-binary, trans and agender people. The asterisk represents all non-binary gender identities.

Greta Gaard wrote, connecting multiple struggles:

> "As the slogan goes, 'I'll be post-feminist in the post-patriarchy'—and when sexism, heterosexism, transphobia, classism, racism, speciesism, ableism, ageism, and the global inequalities produced and exacerbated by industrial capitalism and the legacies of colonialism cease to be a problem, then feminism will have accomplished its goals and outlived its usefulness." (Gaard, 2011, p. 43).

Hofmüller has been part of this longer history of feminist tech events, servers, and networks. She (among many other things) co-founded mur.at in 1998. In the mid 90s the open network infrastructure that was previously provided mostly by universities, began to dwindle, due to a commercialisation of the Internet and private funding of university infrastructure. Many resources became available only to employees and students. This was the impulse for founding mur.at, a server farm at the service of local artistic and cultural initiatives, committed to Free/Libre and Open Source Software and collaborative small-scale solutions. Mur.at has hosted systerserver since 2015. Hofmüller was part of Gender Changers Academy, and Eclectic Tech Carnival, which was hosted by esc in 2005 (The /etc development team, 2005). After more than two decades of bringing people together over nice food and feminist technology, she explains why she has developed the patience for learning together:

> "because this is what learning is. If we don't create these spaces where people can express 'I have never done this before', or 'I don't understand how that works,' or 'it's not working on my system,' then we can't share it. If we want to share this other way of doing things, we also have to do it. Always. Networking takes time. It's not only the machines, it's also the people living a good life, and that means time and energy and everything that entails, with all our personalities." (Hofmuller and Botthof, 2022)

Hofmüller joined ATNOFS with esc mkl because she felt that this is the next generation of people who do things. She wanted to bring everything that people already thought about and tried out and experimented with, so that there is an access to lived history, all the contradictions and the doubts, the good and the bad things, everything that already happened, because for the new generation it's something that can only be read about. Even though today things are created in a completely different setting, the questions remain the same: what is it that technology does to us and what could an active role in that look like? What could an infrastructure be that reflects *our* needs? She mentions how it is good to bridge this history while also being sensitive to what has changed. Hofmüller sees this change most clearly in this real wish for collectivity, and in a way that makes space for others. It's not only a wish, it is really a practice. The Code of Conduct at Varia, for example, is something that they live, part of how they do things and they have found ways to enact that. It's not an abstract verbalisation of something they aim for. This is a huge change, Hofmüller observes, over the decades.

With / in limits

Based on two conversations I had with Wendy Van Wynsberghe, Élodie Mugrefya, and Martino Morandi of Constant (Mugrefya, Morandi and Van Wynsberghe, 2022).

Constant is an association for arts and media run by artists, designers, researchers, and hackers based in Brussels, Belgium, founded in 1997. Constant works to systematically create collaborative situations that engage with the challenges of contemporary technolife. At Constant, they develop projects at the intersections of art and technology in which, for them, it is important to make connections between intersectional feminisms, free software, and copyleft approaches. Together, these allow them to imagine webs of interdependencies, infrastructures of solidarity, poetic algorithms, conflicted data processing practices, and principles for multi- and/or fuzzy authorship. For them, generating puzzling questions is a strategy that offers openings for profound, complex, and playful research. These questions are stumbling blocks that help them realise that the technologies they are interested in are not about fluency, smoothness, optimisation, and efficiency, but are instead full of assumptions and problems that demand our continuous attention (Mugrefya and Westenberg, 2022).

Constant works with many terms, they have a habit of collecting words, of thinking in multiplicities. True to this, yet working with / in limits, they settled on three words that were already part of their vocabulary, and revisited them to see how they relate to environmental concerns. Environmental and social issues are so interconnected, and it's interesting to see how taking care of small scale infrastructure in a thoughtful way has positive impacts across the board. Constant is thinking more and more in terms of these interconnections. When it comes to online content for instance, they aim to stay within the limits of the space they have on the server. They decided not to grow this space but to stick to what they already have. When they reach the maximum, they remove or downsize files. Constant has a long memory—they keep content from their entire history online and available—but this long presence is cheap in terms of space, because the older content is so small in comparison to content produced today. The more current practices are more problematic. Even though they max out their disk space occasionally, their system administrator will warn them in advance, giving them time to decide what to do instead of fixing it in a panic. They want to turn this into a protocol, into a regular practice.

Linking environmental questions solely to CO_2 emissions and electricity use pushes us into a small corner of metrics and narrow ways of engaging with alternative practices. It leads to an efficiency focused response rather than one that engages with the conditions of use. Constant prefers a more holistic approach, because the most effective way of dealing with the environmental impact of computing is an approach that diverts from the 'cloud paradigm,' which might be super efficient, but propagates the narrative of unlimited and eternal use of services and storage. It pushes you to consume more. Increased efficiency leads to the dreaded rebound effect, when the efficiency gains of a technology lead to a cost reduction which subsequently leads to an increase in the use of the technology, and overall use of resources. Constant may be less efficient but is more aware of conditions of use, not pushing for more but working with / in limits.

Speculative Libre Intersectional Technologies

In the coming years, Constant will focus their work through this acronym: SPLINT, which stands for Speculative Libre Intersectional Technologies.

> "Speculative Libre Intersectional Technologies is a term invented to signal Constant's commitment to answer the question: What could/should free and intersectional technologies do? More specifically, what kinds of devices

> and practices could address and counteract the systemic discriminations, oppressions and exclusions at play in today's technologies? SPLINT explores the potential of technology for artistic practice and vice versa, at the intersection of intersectional feminism and open source software. SPLINT investigates the discriminations and structural problems inherent in technology, and nurtures the imagination and imaginative capacity of techno-realities that can contribute to an open, experimental and equitable digital art field." (Constant, 2023)

The overarching aim is to pay attention to where violence and oppression happen in society. Constant does not want to define this word too much yet because it is a striving, a goal for the coming years, it has yet to develop. I love the acronym, something that allows mending something broken by temporarily supporting it and the structures around it. One clear environmental focus is interspecies relationships. This theme will be the main focus during year one, but they aim to carry the sensitivity of this focus throughout the whole five year period. Another clearly environmental focus is techno-disobedience, which relates to the question of resource use and e-waste. The term stems from Ernesto Oroza's research on Cuban repair culture and the creative repurposing of old devices out of necessity, which relates to making do with what is already there (Oroza, 2009, 2016).

Possible ongoingness

'Possible ongoingness' is the third term Constant felt resonated with their practice. It came up in a conversation between STS scholar Donna Haraway and literary theorist Cary Wolfe, and captures the strive to support and nourish practices that involve feeling responsible towards others and the world, to work towards something common in the midst of political polarisation and climate catastrophe.

> Carry Wolfe: "Let's start with a problem that we all agree we share."
>
> Donna Harraway: "We all share this problem, and we all have very different ideas about what to do about it. That's already hard enough. That does not mean the science is not settled on climate change, or that relativism reigns; it does mean learning to compose possible ongoingness inside relentlessly

> diffracting worlds. And we need resolutely to keep cosmopolitical practices going here, focusing on those practices that can build a common-enough world." (Haraway, 2016, p. 288)

One way Constant practices this is through the sharing of its infrastructure with others. Etherpad, for instance, is shared with many organisations and people. Sometimes they find out that people encounter Constant uniquely through their etherpad service and only later find out they are an actual organisation that does other things too. Big Blue Button (BBB) followed a similar pattern. At first it became a necessity for Constant itself because of the first lockdown. They needed it and had the resources to set it up. They decided to share it. Everyone who wanted to use it could book a timeslot in the agenda. This resulted in a large diversity of groups and individuals making use of it, from activist groups to students and more. They have an archive of the reservations, which has become potential evidence to show to those who refuse to consider alternatives to Big Tech. It demonstrates that it works and that there is a real need and interest. Environmentally, it is a great idea to share resources—not everyone needs to have their own server with BBB and etherpad. Besides, this sharing also strengthens relations between people and organisations, building networks of care and trust.

There is an element of care in the way they treat these shared services. Etherpads that are not used for a year are turned static, authorship colours are removed, as well as the history of all edits of the page, which together save a lot of space. These space-saving methods were a result of the database growing too much. These seemingly small and practical gestures could have a big impact if they were practised more widely; if we refused to grow storage space and instead looked for ways to stay with / in limits.

Echoes from different past practices

These were the six different practises that came together during ATNOFS. Their inheritance is quite distinct from that of permacomputing. The history of feminist technological practices has no direct connections to the WEC and soft technology.[30] The earliest examples appeared in the early 90s, when the term soft technology had long been forgotten and its contents were assimilated in the digital revolution announced by Reagan a decade earlier. The WEC and CQ made place for Wired, which published its first issue in 1993, promoting a very much WEC inspired digital generation that would create a non-hierarchical, peer-to-peer, collaborative society connected through flows of information (Turner, 2006, p. 209). In 1990 the US Defense Departments's Advanced Research Projects Agency (ARPA) transferred control over the Internet backbone to the US National Science Foundation (NSF), which just like ARPA prohibited commercial use of the Internet, until 1995. Until that year, many alternative networks had sprung up and millions of people were using email, BBSs and Usenet. In 1990 the World Wide Web was created, allowing new ways to navigate information, including multimedia content. When in 1995 the commercialisation of the Internet had begun, and universities were no longer the only point of access to the Internet, for a brief moment, there was an explosion of creative experimentation on small and independently hosted servers, in the US and EU, including technofeminist projects.[31]

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[30] The only direct connection I found, thanks to curator and researcher Magda Tyżlik-Carver, was *The New Woman's Survival Catalog*, which was advertised as the feminist Whole Earth Catalog but was a collection of feminist resources, not tools or things to buy (Grimstad and Rennie, 1973; Miller, 2018).

Cyberfeminism and technofeminism

One of the earliest and main influences on technofeminist practices whose work is still circulating is Donna Haraway, whose *A Cyborg Manifesto: Science, technology and socialist-feminism in the late twentieth century* became a great inspiration to the cyberfeminist movement which also inspired broader technofeminist practices (Haraway, 1991).[32] The metaphorical proposition of the figure of the cyborg as blurring the lines between dichotomies of nature/culture and human/machine and the suggestion of kinship based on affinities rather than identity categories were meant to inspire the forming of alliances between otherwise separated groups of feminists and to release gender of its binary framing. The text argues for a rejection of universal and totalising theory and therefore also of one single feminism, and that taking responsibility for the social relations of science and technology, means rejecting the dualism of technology as liberatory versus technology as domination, to make place for a "powerful infidel heteroglossia" (Haraway, 1991, p. 316). Even though the manifesto does not embrace technology uncritically, it is aware of its patriarchal military-industrial history, it still places high hopes in its liberatory potential. In that respect, Haraway was not immune to the tech-utopianism surrounding her in California in the 80s. She simultaneously critiques techno-scientific rationality, developed in detail in *Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective*, while also celebrating the technological outcome of this disembodied worldview as the opening to new potentialities for resistance against it (Haraway, 1988; Wajcman, 2006). This is only one of the influences of technofeminist praxis, that shows how the histories of mainstream technological discourse and that of alternatives to it, are inextricably intertwined.[33]

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[31] The term technofeminism was coined by sociologist Judy Wajcman (2006) in her similarly named book, situating it in the overlaps between science and technology studies (STS) and feminist technology studies. The book *The Beautiful Warriors: Technofeminist praxis in the 21st century* uses the term to designate practices that negotiate gender politics with reference to technology (Sollfrank, 2020).

[32] Cyberfeminism is the name given to a diversity of practices starting in the mid 80s, inspired by among others Haraway's *A Cyborg Manifesto* (1991) and Sadie Plant's *Zeros and Ones* (1997). The term was first used in 1991 by Plant and art collective VNS Matrix, which published the *Cyberfeminist Manifesto* that same year. It was a multiplicity of feminist, techno-utopian visions from a variety of disciplines, associated with the *Old Boys Network* platform founded in Berlin, 1997. A contemporary collection of cyberfeminist work is gathered in the *Cyberfeminism Index* by Mindy Seu (2020).

Technofeminist practices did differ from WEC and Wired's techno-utopianism at a fundamental level though, centring the social embedding of technology and putting issues of race, class and gender at the forefront, rather than neglecting them in favour of a focus on 'the right tool'. These practices build upon a different history, one that has always prioritised marginalised voices and resisted the patriarchal power structures reinforced through technology. Not long after Haraway first published her manifesto, in 1985, other voices examined technology and gender's interrelations with a less techno-utopian message. In 1991, Wajcman (2006, p. 96) elaborated why "[t]here is nothing inherently progressive about a cyborgian identification with machines." In her work *Technofeminism*, she points to the need for transformative *practice*, rather than rhetoric, "a sense of how feminists could act to change, or at least redirect technologies, rather than just reconfiguring them in our writings" (Wajcman, 2006, p. 101). While Haraway's manifesto is a critique of binary thinking, a rejection of dualisms, it essentially argues for a binary choice between a total rejection or an ambivalent embrace of technology. Wajcman points out how Haraway caricaturises and essentialises other forms of feminist research and practice, that *are* aware of the danger of biological essentialism and are working towards practical emancipatory politics.[34] Her proposition to address the embedded inequality and privilege in socio-technical networks through both micro-politics at the level of local activism, as well as macro-politics of global movements, is practised by communities surrounding feminist servers. In these communities, technologies are reinterpreted as tools for political organisation, with awareness of how these same technologies are implicated in countering such politics, a relational approach that sees gender relations and socio-technical networks as unfinished and mutually constituting processes.

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[33] An example of the two discourses overlapping can be found in the blurring of the lines between human/machine, mind/body and nature/culture that was proposed in the text *Cyberspace and the American Dream: A Magna Carta for the knowledge Age*, written by George Keyworth, Reagan's former science adviser, Esther Dyson, George Gilder and Alvin Toffler. The text describes cyberspace as more ecosystem than machine, and the mind as overthrowing matter. This text helped deregulate the US telecommunications industry, mostly based on the argument that digital technologies drove egalitarian empowerment (Turner, 2006).

Safe spaces and doing speculatively

During the 00s the commercial Internet gave rise to increasingly dominant large platforms that weren't protecting or reflecting the needs of women, feminists and LGBTQI+ people. For these groups, the dream of the Internet leading to a non-hierarchical, peer-to-peer, collaborative society turned into a dystopia filled with harassment, intimidation, discrimination and censorship.[35] The need for safer spaces became more and more urgent, as the multinationals in control of these platforms built their business model on targeted advertisement and user surveillance, leading to a growth of the user-base outweighing the protection of users (from other users, corporations and governments). Next to strategic politics, lobbying for greater online and irl safety, organising protests and demanding attention for the oppression of and violence against women and gender minorities, some communities started adopting prefigurative strategies by creating these safer spaces themselves.[36] In 2005 Systerserver, the first feminist server project was started, joined in 2014 by Anarchaserver during the TransHackFeminist convergence in Calafou, Kefir in Mexico (2015) and Vedetas and Cl4ndestinas in Brazil (2016) (Spideralex, 2018). The momentum for these practices in the EU was build by the activities of *Genderchangers* started in 1999, the */ETC* started in 2002, the *Feminist Server Summit* at the *Are you being served?* event in 2013 and the TransHackFeminist (THF!) Convergence at Calafou in 2014. How did these practices challenge dominant definitions of technology?

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[34] Wajcman is critical of certain aspects of Haraway's text, calling the hopes that cyberspace is the end of embodied sex differences a technological and biological determinism in postmodern guise, yet recognises its importance and builds upon its strengths, grounding the call for taking responsibility for the social relations of science and technology in a materialist approach to the social study of technology (Wajcman, 2006, p. 106).

[35] While the Internet became a more hostile place for marginalised people, it also proved invaluable for many as a place to find community, making it all the more urgent to build safer spaces.

[36] There were already many autonomous servers in existence, with digital services for activists, such as Autistici (2001) and Riseup (1999/2000), but none with a specific feminist agenda. Feminist servers with safety as their main focus didn't grow into servers hosting a large use-base. They remained 'embryonic', yet have shown the possibility of such projects (Toupin and Hache, 2015).

Feminist conceptions of technology have posed two core challenges. First of all, it has allowed for a broadening of what is commonly understood as technology, and a questioning of positive and negative value associated with so-called high- and low-tech. Ursula Le Guin captures this beautifully in *A Rant About Technology*:

> "[...] technology is how a society copes with physical reality: how people get and keep and cook food, how they clothe themselves, what their power sources are. [...] Technology is the active human interface with the material world. But the word is consistently misused to mean only the enormously complex and specialised technologies of the past few decades, supported by massive exploitation both of natural and human resources." (Le Guin, 2004)

Wajcman described this shift in the association of technology with so-called 'high technology'. In *Technofeminism* she outlines how 'male machines' replaced 'female fabrics' and tech became more and more associated with masculinity, associated with industrial, governmental, and militaristic practices (Wajcman, 2006). Because of feminist and decolonial perspectives, which also challenged this narrow understanding of technology, this interpretation is now more and more reconsidered. Western high-tech is no longer seen as 'the' technology, as universal.

The second core challenge is one countering the assumption that tech is politically neutral and thus equally accessible and safe for all. Technofeminist practices tell stories of power and unmask false claims of universality (Star, 1990). Star proposed starting this process of unmasking at the 'zero point', the point in between two dichotomies, with positions that do not fit the standard, thereby entering a high tension zone, which gives insight into the standardised aspects of networks that are stable to most, yet violent to some and stabilised by the invisible work of others (Star, 1990). This point of departure allows us to ask how it could be otherwise, because, as Star pointedly remarks, there is nothing inevitable about any science or technology. What follows once this opening is created, brings ideas about how technology could be otherwise and the practical implementation of such ideas together. Artist, activist and writer Femke Snelting describes how this brings tension, between dreaming and implementing. She outlines how feminist server praxis, for instance, on the one hand relies on FLOSS, because its freedoms to reuse and modify allow for speculative design, while on the other hand FLOSS communities' general technocratic focus and trust in meritocracy makes it a hostile place for speculation.[37] This tension, between the server as technical reality and speculative possibility, lies at the heart of feminist server practices (Snelting, 2015).

This tension leads to a practice that refuses to let the infrastructure disappear into the background, by resisting seamlessness, efficiency and scale (Reiter *et al.*, 2014; Niederberger, 2019). Because the servers are both a practical as well as a (prefigurative) political project, showing the conditions of production of the services being offered, means showing the otherwise invisible labour of maintenance, as well as offering insight into the patchwork of tools constituting a service. This gives insight into the inner workings of the server, which impacts how a community relates to it, what it expects of a service and the people working to offer it. Varia's patchwork computing and the way rosa was prepared for ATNOFS, are examples of this. This is what sociologist Spideralex and ethnographer Sophie Toupin call 'doing speculatively', allowing a prefiguration of the technologies trans*feminists wish for, imaginaries that can reshape technology (Toupin and Spideralex, 2018). Next to 'doing speculatively' and resisting seamlessness, other challenges posed to hegemonic views on tech are put into words by the *Feminist Server Manifesto*, which was an outcome of the *Feminist Server Summit*, written down at *Art Meets Radical Openness* in Linz, 2014. It wasn't meant to become a foundational text and has grown into an evolving point of reference for many projects interested in reimagining technology otherwise.[38] It has connections to, and has inspired many of the practises I described as part of ATNOFS, which I will briefly revisit in the conclusion.

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[37] For an in-depth discussion of the paradoxes and tensions arising when FLOSS licenses and open source ideology are applied to a cultural context, please see *Sandbox Culture: A Study of the Application of Free and Open Source Software Licensing Ideas to Art and Cultural Production* (Mansoux, 2017).

[38] The *Feminist Server Manifesto* has been revisited several times. In 2022 it turned into *A wishlist for trans*feminist servers*, a set of wishes for different tech for different worlds (Trans feminist servers, 2024).

Ecofeminist servers

There is no such thing as an ecofeminist server, at least there isn't one identified as such as far as I know. Just as this chapter shamelessly claimed space for the environmental value of technofeminist practises by coining new terms, I will end this chapter by exploring the potential of ecofeminist servers by connecting the practises around feminist servers with the discourse of ecofeminism.

I am aware of the turbulent history of the term, and of the very diverse academic and activist practices associated with it. I'm inspired by Miriam Bahaffou and Julie Gorecki's (2022) introduction to the New French Edition of *La Feminisme ou La Mort* by Francoise D'Eaubonne. They describe how, for them, there is a clear connection between the treatment of nature and that of women, the enslaved, disabled, and racialised. All are treated as terrain of experimentation or conquest. They point out the whiteness of ecofeminism's history and show how colonisation is painfully absent from the writings of d'Eaubonne, who coined the term in 1972. They dismiss the apolitical, ahistorical type of ecofeminism that reproduces white privilege as well as the equally privileged DIY lifestyles that require materials created under horrible conditions by workers on the other side of the world. Yet they see potential in d'Eaubonne's call to link theory and practice and celebrate calls for "feminist system change not climate change" by women and gender minorities around the world (Bahaffou and Gorecki, 2022, p. 54).

> "In a damaged world, we feel urgently that reinvention cannot happen except through creating microsynergies, local alliances, and piecemeal collaborations." (Bahaffou and Gorecki, 2022, p. 27)

Even though they do not all identify as ecofeminist, the practices described in this chapter are specific to their local context yet share the desire to connect the struggle against different oppressions and to transform this desire into ways of doing: something Liboiron (2021, p. 122) calls axiology-in-praxis, in *Pollution is Colonialism.* Liboiron describes the way CLEAR lab approaches anti-colonialism as land relations at the scale of protocol. It is impossible to confront land theft and ongoing colonial violence when you're doing everyday research in a lab, but you can manifest your values in the way you do your daily work (Liboiron, 2021). An ecofeminist server explores how the connection between the treatment of nature, women, the enslaved, disabled, and racialised can be turned into ethical praxis at multiple scales, from ecofeminist and always unfinished space making and patchwork computing, to the strategic politics of organising protests and maintaining archives of community memory at risk of erasure.

Activism at different scales is not a binary matter, of either/or. Debora Prado, in *Community networks and feminist infrastructure* (2019), building upon the work of Stengers and Pignarre's *Capitalist Sorcery* (2010) and Haraway's *Situated Knowledges* (1988), reflects on the confrontation between activism at different scales; on the one hand activism aiming at global and systemic change, and on the other activism aiming at changing local practices which make use of a diversity of situated knowledge and experience. She argues that, in certain contexts, a dismissal of local knowledge in favour of the imperative of total system change can become a way to shut down discussion and avoid having to think about how our own practices reproduce inequalities: "It is easy to conclude that technologies are colonised and colonising. But it's hard to accept that we, to some extent, are too." (Prado, 2019) A decolonial ecofeminism applied to tech infrastructure can be a way to think through resistance to these connected oppressions at multiple scales; from creating safe online spaces for marginalised communities to political action demanding better working conditions in technology manufacturing; from supply chain transparency to repairable devices; out of concern for a damaged earth and in solidarity with those who mined the raw materials and worked to produce the devices needed to accommodate those safe online spaces.

Conclusion

Ecofeminist server practices build on a long history of activist organising and technofeminist praxis. ATNOFS has shown that there is nothing left of the outright techno-utopianism of Wired and very little of the ambivalent optimism of Haraway. Instead, these practises build upon the broadening of what is considered technology in the first place, removing it from the masculine world of high-tech and bringing it back into the domain of women, gender minorities, BIPOC and the disabled. These practises are supported by the work of both feminist, disabled and decolonial scholars as well as sci-fi writers such as K. Le Guin and Octavia Butler. The 'enoughness' of Appropriate Technology posed a 'feminine' threat to the masculinised technological vanguardism of the 1980s, but didn't engage questions of race, gender or class, nor did it engage with the question of why certain technology became dominant. Permacomputing brings an environmental focus and degrowth practice to computing, yet doesn't strategically confront computing's role in capitalism. It is starting to pay careful and explicit attention to questions of class, ethnicity, gender and disability and how certain inequalities might be reproduced through computing practices. Ecofeminist server practices confront these questions head on. They centre social justice and aim to connect those struggles, firmly focussing on embedding the technical within the social world. They largely abandon Haraway's techno-utopianism, but build on her insistence on situated knowledges and Star's interrogation of the 'seamlessness' of technology relying on invisible work. Feminism brings an awareness to invisible labour, and confronts technology's role in capitalism. These core challenges opened a space for asking how technology could be otherwise, something taken up in different ways by experiments with feminist servers.

Ecofeminist and Always Unfinished Space Making engages the paradox of sustainable and feminist tech by making do with what is there as a catalyst for doing tech otherwise. Instead of a tool-focused approach, it is community focused; tech features to support the making of space for community and ways to organise. Its ongoingness in precarious conditions requires collective learning and a situated approach, practices that work in a specific context: reconfiguring scale. *I diakomistis* faces a similar challenge of sustaining activity under precarious conditions. It has no environmental focus, yet has the tiniest footprint because of its nomadic existence. I diakomistis relies on a network of care and trust, a sharing of resources and skills with other organisations and groups, embedded in a long history of feminist technological skill sharing connecting the participating groups of ATNOFS. *Jenga Computing* practises the fragile balance of working with limited time and resources, which translates to making do with whatever they can find and a strong commitment to optimising to remain lean so it all works on older hardware. It combines this technical praxis with providing a safe space for its community through careful moderation guided by a Code of Conduct, prioritising community needs over scale.

Patchwork computing's seamful collection of custom tools which support work rejects automation, and thereby obfuscation, of processes on a server. Its language modding is a reflection of making technology fit social requirements, rather than the other way around. At the risk of lowering security, it removes hierarchies by giving everyone root access to the server as a way to share responsibilities and thereby share a space, rather than offer services. Patchwork computing makes choices about which services need to be available when, based on community capacity and needs as well as machine capacity, working within community and machine limits. The *seismography of artistic practices* of esc mkl builds up and fosters creative potential of artistic, feminist and activist practices, while using resources as binding element in an ecofeminist discussion of tech. The practice brings the connections between feminist, LGBTQIA+, decolonial and environmental struggles to light. Esc mkl emphasises the importance of skill sharing in search of doing things otherwise and of bringing lived history to the table, while also recognising what is new and has changed to foster that. Constant's commitment to working *with / in limits* is a challenge to the cloud computing paradigm with its limitless expansion, and the industry supported focus on CO_2 and electricity, which obfuscates the underlying cause of wastefulness and damage. With the acronym *SPLINT* Constant strives to counteract systemic discriminations, oppressions and exclusions at play in tech. It aligns with hypha in the search for *possible ongoingness* as the building of common spaces, a common-enough world, in the midst of political polarisation and climate catastrophe.

What connects the practises discussed in this chapter is the everyday practice of resisting Big Tech for social justice reasons, which excludes and exploits marginalised people and damages the planet. Even though the environmental aspect of this isn't always articulated, the choices made lead to environmentally more sound practises across the board and have a lot to offer to other practices looking to reposition and redefine technology in the climate crisis. Not only the centring of issues of race, gender, ability and class, but also the connection between prefigurative and strategic politics and perhaps most importantly, the collaborations and sharing of knowledge, skills and resources among groups active in the field. What ecofeminism has to offer these practices, as a philosophy connecting different struggles—and what practices around feminist servers have to offer other practices linking technology and environmentalism—is a strong focus on the role of tech in society in reproducing these oppressions, marginalisations and exclusions. Feminist server practices prioritise social and community needs over tools, linking strategic politics with prefigurative politics by examining how inequality is reproduced at different scales. They refuse Big Tech's destructive growth-at-all-cost paradigm and work on viable alternatives at the scale of their community while connecting with like-minded groups. Feminist technology is not commonly associated with environmentalism, yet new attempts to reduce the damaging effects of tech could learn a lot from these practices and the struggles, research and writing that informs it.

Ecofeminist servers make it very clear that working on a small scale isn't inconsequential. Working towards a safe space for marginalised groups that face threats is not 'lifestyle activism' or failing to overthrow systems, it is addressing a direct need of a community. A feminist server is not a 'nice to have' wood stove or cider press. Even if it concerns less urgent experimental practices, such as changing the language with which a server addresses its users to better fit the community, it is not about lifestyle but about a fundamentally different attitude to tech. It is not considered liberating or democratising by nature (its military-industrial origins aren't forgotten) yet it is reimagined at the service of community and adapted to it. This activism at different scales will be examined further in the next chapter, which returns to the start of this dissertation: to the image that would change the world and a visual redefinition of technology through the tiniest element: the small image.

Chapter 5

The Small File Photo Festival

While I was brainstorming with curators Jon Uriarte, Sam Mercer, researcher Ioanna Zouli and producer and artist Arieh Frosh, the team of the Digital Programme at The Photographers' Gallery, about an event that would bring together the audience of the Programme and my research, ideas flew back and forth. Nothing quite clicked until I proposed an idea that arose when I met media scholar Laura U. Marks during an online event at Merz Academy (2022).[1] *Marks was invited to speak about the carbon footprint of streaming media and her work on the* Small File Media Festival*, which celebrates small file video, film and media art. I was invited to speak about edge computing and how cloud service providers hide their own impact and shift responsibility for computation's environmental footprint to consumers, based on the paper* Refusing the Burden of Computation: Edge Computing and Sustainable ICT*, which became the basis of this dissertation's first chapter (de Valk, 2021b).*[2] *At first glance, Marks' argument for creators to embrace small file media as resistance against the high resolution, high bit rate default of most streaming media, seemed to be at odds with my refusal to place responsibility for large scale environmental harm with individuals. In some ways, it felt as if small file media were another version of a campaign against littering, this time translated to a carbon footprint. Yet both perspectives shared two common goals: a resistance against platforms dictating the terms on which people communicate, consume*

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[1] The event took place in Stuttgart, November 30 2022, as part of the lecture series *On the Edge – Conversations on Sustainability in Art, Design and Media*, curated by Internet artist and theorist Olia Lialina.

[2] The paper was an outcome of my participation in the workshop *Research Refusal* which took place in 2021. The workshop was a collaboration between *Digital Aesthetics Research Center*, Aarhus University, *Center for the Study of the Networked Image*, London South Bank University and *Transmediale* festival for art and digital culture in Berlin.

media and express themselves; and lowering the negative environmental impact of the infrastructures transferring, storing and displaying the networked image. This combination of resistance and proposal of alternatives at the level of the circulation of digital imagery was a perfect fit for the event at TPG. With the blessings of Marks and her team, we decided to organise the Small File Photo Festival*, a one day event celebrating small file photography. This chapter explores the potential of a molecular revolution through the visual bond of the small image.*[3]

Introduction

This chapter revisits the start of this thesis, the image that would change the world, and transitions to the image at the end of the world. It aims to break capitalist sorcery's most powerful spells and infernal alternatives through the lens of the small image, a visual redefinition of technology. The magic words efficiency and scale are interrogated and the potency of the small image as counter-magic, a politics expressed in imagery, is tested through a discussion of the Small File Photo Festival, an event which took place the 28th of January 2023 at The Photographers' Gallery.[4]

In the first section I explore the issue of scale through a discussion of how the small image confronts the climate crisis and ask if positioning the individual act against the systemic problem is an honest representation of the choices faced by activists. By travelling through the previous chapters I demonstrate that it is not that simple. With small file photography, artists experiment with aligning means and ends, a prefigurative politics, and this visual resistance relates to power in an embodied way. Individual responsibility for systemic problems should be refused, yet prefigurative politics alongside strategic politics are the much needed pragmatic and experimental performing of other worlds that demonstrate that computing otherwise is possible. The *Small File Media Festival*'s ecomedia are a challenge to "bandwidth imperialism" and celebrate smallness as decolonial and rich expression of culture (Marks and Przedpełski, 2021). This effort is confronted with critique based on a powerful spell: efficiency.

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[3] In this chapter, I connect the prefigurative politics expressed in certain small file media produced today with philosophers Felix Guattari and Suely Rolnik's *Molecular revolution in Brazil* (2007) and with Hito Steyerl's discussion of Dziga Vertov's visual bond in her *In Defense of the Poor Image* (2009).

[4] I use the term 'small image' throughout the chapter to refer to digital images that are purposefully kept small, in terms of file size, and computationally lightweight to reduce the load they pose on networks, storage media, computer hardware and the environment. It doesn't concern images as part of machine vision, as these are always already elements in a regime of capture, accumulation and extraction. I will unpack the implications of this term throughout the chapter.

In the second section I discuss this spell, which the small image and the other practices in this dissertation face. I explore it, and its accompanying quantification (as evaluation of success), and how it is often proposed as a solution to the damage caused by overproduction and consumption, the base on which the myth of dematerialisation builds. Efficiency at the scale of IT hardware is used to take discussions about the environmental impact of IT out of political decision making processes. Increases in efficiency would supposedly lead to a less damaging tech industry without having to regulate it or change the way it operates. One level down, the opposite problem is encountered, discussed through Wirth's law: "[s]oftware is getting slower more rapidly than hardware becomes faster" (Wirth, 1995, p. 64). Software efficiency is not profitable and thus not pursued. Yet another level down, an increase in efficiency at the level of digital image compression lead to an increase in resource use, because it sparked the rise of digital photography.

In the third section I explore how the small image challenges dominant definitions of technology and breaks the spells of scale and efficiency, by discussing four works featured at the *Small File Photo Festival*: *Mavicazine* (2022) by Renaat Nijs, *Gameboy Ansel Adams* (2022) by Sofia Lee, *My Nonhuman Friends* (2021) by Nika Sandler and *Audible Photographs* (2022) by William J. Brooks. In the final section of the chapter I'll discuss two theories connecting digital imagery, smallness and the environment. I'll discuss media theorist Sean Cubitt's concept of ecoaesthetics and artist Hito Steyerl's poor image, and how the small image relates to them. The image at the end of the world's 'Quality of Experience' doesn't rely on high resolutions, its material grounding creates room for a diverse, rich, creative and decolonial networked image. The small image is a redefinition of tech through a strong political, environmental, decolonial stance which, in combination with strategic politics, challenges capitalist sorcery's most powerful spells.

Scale (the small image versus the climate crisis)

How does the small image confront the large scale systemic problems discussed in chapter 1? To get an idea of the connection, I will travel through the chapters towards the tiny scale of the digital image, tracing different challenges to the spell of scale.

In chapter 1 I discussed how a corporate agenda was introduced into international debate about how to tackle the climate crisis early on, leading to an embrace of the concept of 'decoupling' economic growth from environmental damage and depletion, a dematerialisation of production through the use of technology. Big Tech reframed 'business as usual' as 'sustainable ICT' and placed the responsibility for computing's environmental cost with businesses and consumers on the edge of networks. I introduced the concepts of capitalist sorcery and capture to explain the lack of resistance against these developments. In the case of IT, especially since the COVID-19 pandemic, this concerns not only a capture of the imagination to think outside the narrative of progress and innovation, it also concerns an actual capture, vendor lock-in. The greenwashing strategies of the tech industry I discussed in chapter 1 have shown that the refusal of individual responsibility for systemic problems such as climate change, is essential: holding accountable those who lead harmful industries, and the governments aiding them, by building public pressure and demanding regulation. Small scale practices, such as alternative networks and ways of computing otherwise, reimagine the infrastructures people depend on for organising collective action and refuse to put these in the hands of the lords of platform. They challenge capture and pragmatically and experimentally perform other worlds. There is more to it than an infrastructural escape from capture, ideas about the possible are also released: they demonstrate that there are many different alternatives already in existence. This breaking of the spell is needed to create the public pressure required for strategic politics at a larger scale.

In chapter 2 the discussion of Appropriate Technology showed how prefigurative politics alone don't stand a chance against the power of those with vested interest in the growth of technological systems, which support their power. Even though the movement's emphasis on degrowth, citizen science, a humanising of tech and taking control over the means of media production are still relevant today, Appropriate Technology's lack of a philosophy of change, of how its practices would become transformative at a larger scale, meant there were no strategies in place once soft technology's ephemeralisation became the dominant conception of technology's role in society. Appropriate Technology didn't have a theory of why certain technology became dominant, of how technology reinforces existing power structures, merely demonstrating the 'right tools' would suffice. When certain ideas surfacing at the time of AT reappeared today and found their way into the practice of permacomputing, discussed in chapter 3, this lack of strategic politics is to some extent repeated. Permacomputing's prefigurative politics can be thought of as an embodied relation to power, which has the potential to align social and media movements, but hasn't yet made this a reality. It lacks a clear strategy to pursue its political goals of equal access and resistance to Big Tech monopolies, requiring alliances with other transformative projects and social movements.

Chapter 4 discussed how feminist server practices puts these politics front and centre and creates a strong connection between prefigurative and strategic politics. These practices work towards safe spaces for marginalised groups that face threats and address a direct need of a community. Even if it concerns less urgent experimental practices, such as changing the language with which a server addresses its users to better fit the community, it demonstrates a fundamentally different attitude to tech: its military-industrial origins aren't forgotten, yet computing is reimagined at the service of community and adapted to it. It becomes an expression of the decolonial, (eco)feminist goals it aims to achieve, while also offering infrastructural support for the organising needed to pursue these goals. Feminist server practices maintain a strong focus on social and community needs over tools, linking strategic politics with prefigurative politics through examining how inequality is reproduced at different scales, from the large scale of the role of computing in upholding patriarchal power to the small scale of the wording by which a server addresses its users.

Scalability is often used in a rhetorical sense, to dismiss counter-narratives and alternative practices. It is a strategy that makes this dismissal seem reasonable. When proposing doing computing otherwise within a local context, the question: 'but does it scale?' shuts down discussion in a way that is reminiscent of Starhawk's desciption of people's reaction to the word 'magic', something not to be taken serious (Pignarre and Stengers, 2010). If the scale at which a certain problem operates is left unscrutinised, it can lead to scalar mismatches, as Liboiron (2021) has powerfully pointed out in their discussion of scale in relation to plastic pollution and the myth of abstention and consumer choice in a world where plastics leak into every corner of the planet, including our bodies. Even if we personally avoid using plastics and pick up after ourselves, the problem is not operating at the same scale as the solution (Liboiron, 2021, p. 101). This careful interrogation of scale shows how problems are reproduced at multiple scales and that scalability itself causes problems. The question 'but does it scale?' is not innocent. Scalability is violent. Star, in *Power, Technology and the Phenomenology of Conventions*, discusses the violence done unto, and the tremendous amount of work done by, those not fitting the standards; standards which are required to make things scalable and only seem smooth to those who 'fit' (Star, 1990). Last but most importantly in the context of this dissertation, scalability banishes diversity, something Tsing (2015, pp. 37–43) explores in *The Mushroom at the End of the World*.

> "The main distinguishing feature between scalable and nonscalable projects is not ethical conduct but rather that the latter are more diverse because they are not geared up for expansion. Nonscalable projects can be terrible or benign; they run the range." (Tsing, 2015, p. 42).

Tsing (2015, p. 38) points out that scalability banishes diversity, and it is in diversity that change might start.

The small image operates at the scale of expressing the wish for, and embodying the goal of a materially lighter, less energy intensive, and globally accessible, even in areas with limited bandwidth, network infrastructure. The current chapter looks at how artists experiment with aligning means and ends, a prefigurative politics, and how this visual resistance relates to power in an embodied way. The small image is aware of its own materiality. Currently there isn't a movement or community of practice that could organise itself and perform strategic politics, however, its otherness and resistance to techno-maximalism perform other worlds and are a valuable companion to strategic politics. As this chapter will discuss, the small image has an (eco)feminist and decolonial agenda. So to answer the question of whether the positioning of the individual act against the systemic problem is an honest representation of the choices faced by activists, each chapter has demonstrated that it is not that simple. Individual responsibility for systemic problems should be refused, yet prefigurative politics alongside strategic politics—with a clear awareness of the different scales at which problems are reproduced—are the much needed pragmatic and experimental performing of other worlds that demonstrate that computing otherwise is possible and doesn't only consist of dreams, but also tests ideas in code, hardware and community organisation.

The small image belongs to what the team organising the *Small File Media Festival* call small-file ecomedia.[5] The festival was started to raise awareness about the carbon footprint of streaming media and to draw attention to appropriate technologies that use little bandwidth.[6] It aims to stimulate the creation and dissemination of small-file ecomedia. Submitted works can be films, video, media art, html or executable files, that are low-bandwidth, with a maximum size of one megabyte per minute. There is no singular definition of small-file ecomedia. I'll describe it based on several texts written by Marks, art historian Yani Kong and media culture scholar Radek Przedpełski. Small-file ecomedia implement the 'computing within limits' strategies of questioning growth, considering models of scarcity and reducing energy and material consumption, at the level of artistic and cultural production (Nardi *et al.*, 2018; Marks and Przedpełski, 2021). They are an intervention in the AI- and VR-enabled HD mainstream, and are often created and experienced with an obsolete, loved and repaired device. They are not an object but a critical practice including the sharing of knowledge (Marks *et al.*, 2023). Small-file ecomedia explore the constraints of smallness as creative potential, a radical new aesthetic practice that transforms limited technical means into social and aesthetic abundance (Marks and Przedpełski, 2021). They decolonise and resist the relentless upgrading of globalised media production and consumption through a practice of enoughness. Small-file media are political, reflecting present social, political, and environmental issues (Marks and Przedpełski, 2021). Even though they are poor images, in the sense of Steyerl's concept, they differ because they don't become small through endless cycles of copying and circulation, they are designed to be small from the start, visually and conceptually rich images that embrace their materiality (Marks *et al.*, 2023; Kong and Marks, 2023).[7] However strong the arguments for small-file ecomedia are, it is faced with the same infernal alternatives and spells as the other practices discussed in this dissertation.

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[5] The Small File Media Festival is an annual festival, started in 2020, and is organised by Laura U. Marks, Radek Przedpełski, Yani Kong, Joey Malbon, Sophia Biedka, Kim Cleroux and Mena El Shazly. In 2022 it screened over 80 submissions from 18 countries.

[6] Marks' research on streaming media's environmental impact is immensely valuable, not only as a very comprehensive review of existing research on the impact of ICT in general and streaming media in specific, but also for providing insight into the reasons for the large discrepancies between different findings. Even though images do not have the same impact as streaming video, they are part of the same industry-driven push for increases in resolution, the purchase of new devices and the propagation of network infrastructure to accommodate the circulation and storage of these ever expanding media.

Efficiency (a technical versus a political problem)

Whereas the spell of scale is invoked to dismiss alternatives to Big Tech, the spell of efficiency is there to ensure alternatives aren't even considered because the problem is framed as technical rather than social, economic and political. The spell of efficiency is blocking transformative action to curb the environmental damage caused by ICT, and on a larger scale, is blocking the debunking of the myth of ephemeralisation. Efficiency comes together with that on which it relies for its power: quantification as evidence. Together, these two project an image of objective evaluation of the effectiveness of measures taken to lower the negative impact of ICT. There is no room or need for decision-making about other causes of the negative impact of it, because supposedly, efficiency will lower the impact so much, no further action is needed, and the numbers speak for themselves.[8] There is however, more than a little room for creativity and politics in the business of quantification, which is meant to demonstrate that increases in efficiency lead to a less damaging tech industry without having to regulate it or change the way it operates.

To give an idea of how these politics play out, the estimations of the percentage of global electricity use by ICT in 2015 calculated by researchers varies between 3.6% to 8% (Marks *et al.*, 2021). While for instance *International Energy Agency* (IEA)'s George Kamiya claims ICT represents 1% of global electricity use, French think tank *The Shift Project*'s working group found streaming media alone to reach that figure (Ferreboeuf *et al.*, 2019;

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[7] Small-file ecomedia emphasise intersectionality, decoloniality and environmentalism whereas Steyerl's focus is on class politics. I will discuss the similarities and differences between the small image and Steyerl's poor image later in this chapter.

[8] I discussed the links between big data, AI, the use of quantification as evidence and the failure to respond to the climate crisis in detail in the panel presentation *Proof You Are Nonhuman* at Transmediale festival 2017, curated by Daphne Dragona and moderated by Geoff Cox (transmediale, 2017, p. 31':25''-51':07'').

Kamiya, 2020). The differences are so big partly due to differences in system boundary, something also demonstrated in the discussion of Google's sustainability report in chapter 1. Some calculations are based on core network electricity use, others include edge and content distribution networks, some include data centres and user devices and a few include the energy required to produce those devices (Marks *et al.*, 2021). Next to these different boundaries, there is simply no way to capture accurate data on most of these elements. Industry doesn't voluntarily publish data about electricity consumption, not even of its core data centres.[9] Next to that, the energy use of, for instance streaming media on phones globally, includes too many variables, from mobile network antennas to screen brightness, the type of device and bit rate of the video consumed. There are a lot of decisions made when quantifying electricity use, that will have a big impact on the outcome, not to mention that only focusing on electricity use and CO_2 emissions misses the many other ways ICT damages the environment. The latter is by far the most effective aspect of the strategy.

Even if just focusing on electricity use, the decisions made while accounting for it are influenced by the political views of the researchers. By political I mean relating to matters of governance and power, for instance the role of governments and corporations in decision making processes about reducing greenhouse gas emissions. Marks et al. distinguished two different political stances within the 22 studies on electricity consumption of ICT they reviewed. One group of researchers concluded that ICT's energy consumption is stable and recommends governments to invest in infrastructure to accommodate future growth. Marks et al. identify another group of researchers who found ICT's electricity consumption was rising and called for degrowth: reducing total consumption (Marks *et al.*, 2021). Interestingly, those arguing that ICT will produce savings in energy in other sectors, larger than their own energy footprint, usually were affiliated with sustainable industry initiatives. Marks et al. (2021) even found cross-sector alliances in for instance *IEA*'s spokesperson George Kamiya's (2020) attack of the Shift Project's streaming video report that caused alarm in 2019. Kamiya states that streaming video's modest energy use is due to the rapid increases in efficiency of data centres, networks and devices. He does admit these gains are unlikely to keep pace with increase in demand and suggests, again, increasing efficiency and decarbonising the grid as solutions.[10] The insistence on efficiency and renewable energy keeps the issue of ICT's negative environmental impact out of political decision making processes, an example of capitalist sorcery's system that depoliticises decision-making processes, a politics that kills politics.

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[9] As discussed in the lecture-performance *A Tale of Two Data Centres*, the revised European Energy Efficiency Directive, which took effect in 2023, obliges data centres that use more than 500 kW to report and publish their yearly electricity and water use. The first deadline was September 15 2024 for the report of 2023, but there are only very fragmented and incomplete reports available at the time of writing (see portfolio).

This strategy is a perfect extension of Buckminster Fuller's ephemeralisation and Reagan's promise of a new economy in which "[...] human invention increasingly makes physical resources obsolete" and receives industry support (Reagan, 1988). Promoting increased efficiency instead of curbing demand has long been an IEA talking point, at times taking miraculous forms. In 2013 the IEA even framed energy efficiency as 'first fuel' because reduced energy demand due to increased efficiency was larger than any single energy supply such as oil or gas (OECD and International Energy Agency, 2013). In 2023 its website bases the estimations of the energy use of data centres and transmission networks on the work of researchers most conservative in their estimations and states: "data centres connected to electricity grids with lower shares of generation based on fossil fuel producing less associated emissions, and hold enormous potential to help (or hinder) global clean energy transitions, including through the digitalisation of the energy sector" (International Energy Agency, 2023).[11] The page was reviewed by no less than three Google representatives, one from Amazon and one from the Dutch Data Center Association, two spokespersons from IEA itself, yet only three researchers without direct industry affiliation (International Energy Agency, 2023).[12] Kamiya's attack has gained a lot of media attention and has successfully spread doubt about the impact of streaming video and thereby diminished pressure on policy makers to regulate the industry.[13]

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[10] The International Energy Agency is an intergovernmental organisation giving policy advice to governments about energy management. It was started in 1974 as part of the OECD framework to provide guidance during and after the oil crisis and later expanded its activities to all energy sources including renewable ones. Its analyses are seen as the gold standard by government officials, energy executives and investors according to Reuters (Green, 2019). It has received criticism on its 2019 report from investors and scientists, for not doing enough to support the Paris Climate Agreement, for downplaying how fast the world could switch to renewable energy and for creating a self-fulfilling prophecy in which they keep predicting increases in demand for fossil fuels, which in turn triggers more investments in their supply, making it harder to transition (Green, 2019).

[11] The digitisation of the energy sector is invariably mentioned as one of the main reasons why ICT infrastructure needs to be expanded. This application of ICT is only a small part of overall ICT use. As discussed in chapter 1, decoupling energy consumption from economic growth is not possible and research has shown that digitalisation is associated with higher levels of economic growth, which in turn increases resource use (Parrique *et al.*, 2019; Santarius, Pohl and Lange, 2020; Freire-González, Padilla Rosa and Raymond, 2024).

Efficiency all the way down?

Efficiency by itself, as explored in chapter 1, is not a factor that diminishes resource use: decoupling economic growth from resource use through technology is a persistent and damaging myth. Since decoupling does not exist, it is simply a displacement of resource intensive industries to other parts of the world rather than an absolute decoupling. Furthermore, efficiency gains lead to increased resource use through the rebound effect, only curbing production and demand—degrowth—can meaningfully promote environmental sustainability. Counting on data centre efficiency does nothing to the impact of streaming video if not coupled with curbing demand and regulating industry. Does this also apply to software efficiency and at an even smaller scale, image compression?

Even though the Jevons paradox doesn't apply to all fields, it does apply to computing. As mentioned earlier, hardware efficiency gains have been accompanied by an increase in resource use and software plays an important role in this process. Wirth's law, named after computer scientist Niklaus Wirth who wrote *A Plea for Lean Software* in 1995, points at the tendency of software size and sluggishness to outweigh gains in hardware efficiency (Wirth, 1995). Andy and Bill's law, 'what Andy giveth, Bill taketh away', points to a similar phenomenon, hinting at what Andy Grove of Intel gives in processor efficiency gains, Bill Gates of Microsoft takes away with more sluggish software. In Wirth's text, he attributes the 'law' to Martin Reiser and formulates it as:[14]

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[12] The Dutch Data Center Association is a data centre industry lobby group. It is featured in *A Tale of Two Data Centres* (see portfolio).

[13] Counting on efficiency ignores the fact that streaming video is suffering from the rebound effect (Jevons paradox). Marks et al. (2021) argue that even though streaming one video consumes less energy than driving a car to the video store, the industry has created new consumption patterns that outweigh those savings. Energy efficiency is not a solution due to this feedback loop between industry efforts to increase demand and increased demand calling for expansion of network infrastructure, which in turn allows for further industry efforts to increase demand, a vicious circle.

[14] Wirth mentions that all these so called laws are expressed in general terms and are not based on empirical observation or scientific scrutiny but he finds his 'laws' to reflect the situation of software and hardware rather well.

> “Software is getting slower more rapidly than hardware becomes faster” and adds “Software expands to fill the available memory.” (Wirth, 1995, p. 64)

He sees hardware efficiency gains combined with consumers’ inability to distinguish between essential and ‘nice to have’ features as main drivers of this development.[15] Rather than aiming for lean software, vendors and consumers alike confuse complexity with sophistication, which creates a profitable dependency of the consumer on the vendor for service and help in using the hard to understand and use product, which leads him to another ‘law’:

> “Customer dependence is more profitable than customer education.” (Wirth, 1995, p. 65)

Wirth’s plea for lean software benefits both users and developers and even though he doesn’t mention this, it is good for the planet too. Lean software would require less energy, while needing only limited amounts of processing power, would run on old hardware, meaning less resource-use in the production of new devices as well as less e-waste. In industry however, everything that would make software lean, is what makes profits lean too. No growth in production and consumption, so no surplus value can be extracted. Lean software leads to independent and empowered users, only buying the software modules and bare minimum hardware they need. Compatibility across the board makes it only too easy for competitors, or worse, Free Software alternatives to step in. There is no need for a rapid upgrade-or-die cycle, no possibility for digital enclosure and the only service needed is some form of education for new users (Wirth, 1995).[16] So even though the rebound effect doesn’t apply to software, leaner software doesn’t lead to an increase in the use of software, industry doesn’t benefit from increased efficiency of consumer software and therefore it isn’t pursued.

Just like Wirth, the Small File Photo Festival (SFPF) didn’t take industry’s profit margins into account. The SFPF chose a relational approach to the networked image: not only encouraging reducing the required processing power and memory to transmit and display an image, which translates to energy and hardware (which in turn translates to energy, resources, labour, transport and e-waste), but a multitude of approaches, while celebrating visual culture. Through the festival, we (the team at TPG) wanted to stimulate the creation of works of art that are a resistance against the quick and shallow consumption of visual material fuelled by the addictive design of social media and instead slow down. The SFPF did not aim for reducing complexity and size on a specialist or purely technical level, but aimed at diversity in approaches, which also increased accessibility for people with different skill levels and areas of expertise. Most of all, we hoped people would have fun with this challenge, and engage with the materiality of the medium of digital photography. We invited submissions to the festival, and posed a file size constraint of 100 kB as a trigger for creative responses by a wide variety of practitioners, from point and shoot aficionados to custom command line compression script sorcerers.[17] This material lightness doesn't rely on technological progress and innovation, all images were small not too long ago, and making digital images smaller made digital photography big.

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[15] Wirth attributed this ‘law’ to naval historian C. Northcote Parkinson, who wrote an article in *The Economist* in 1955 about how bureaucracy tends to fill the time allotted to it regardless the amount of work to be done. Wirth translated this principle to the domain of computing.

[16] Wirth responded to the proliferation of bloated software with *Project Oberon*, which he developed together with Jurg Gutknecht, between 1986 and 1989. *Oberon* was an operating system and programming language with the goal of demonstrating that software can be written needing only a small amount of the processing power and memory usually required and which is comprehensible for developers and users alike. They achieved this by only focusing on the essentials, stripping for example any visuals from the core system, no icons or pictures, only text. The core system only used 200 kB.

The Jevons paradox strikes again

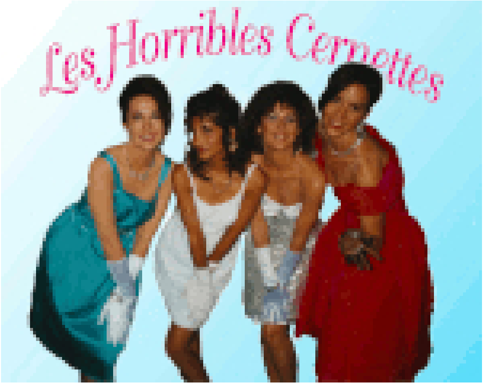

Figure 5.1: de Gennaro, S. (1992) *Les Horribles Cernettes* [Photograph]. © 1992.

The history of the digital image, image compression and digital photography are intimately connected. The alleged first non-technical image on the web appeared around 1992, 30 years ago at the time of writing. It appeared on a website at CERN, where the

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[17] The limit of 100kB was meant to make the challenge accessible for a large audience, because it isn't technically too difficult to stay within it, but it does necessitate radical measures when taking the 5MB average for a high quality, high resolution JPEG as a point of reference (Sneyers, 2023).

World Wide Web was invented 3 years earlier by computer scientist Tim Berners-Lee, by combining the already existing ideas of hypertext, DNS and TCP. The WWW (not the Internet) was initially conceived as an automated system of information sharing between scientists around the world, yet soon started including social information, including that famous 'first' picture. The image in question was a photo by Berners-Lee's colleague Silvano de Gennaro. It was a picture of the parody music group *Les Horribles Cernettes*, made up of four CERN staff members (de Gennaro, 1992). The photo was taken with an analog camera, a print was made, the print was scanned, imported to a Macintosh computer as a GIF file and edited in Photoshop 1.0. According to Gennaro, when Berners-Lee walked into his office and saw the photo on his desktop, he suggested to make a website for the band. He created a webpage for CERN's social events and added the photo. It measured 120 by 50 pixels and Gennaro recalls: "It was the size of a stamp and took about one minute to load on your screen." (Eveleth, 2016) Because images took so long to load, they weren't displayed as part of the page. You had to click on a link to display them. The image was approximately 12 kB.[18]

That same year, 1992, the image compression format JPEG was introduced. The first digital image formats were uncompressed. An image was a long list of sample values, each sample value representing a pixel with a certain intensity of red, green and blue, organised in a rectangular grid. Uncompressed images could save a little space by reducing precision, by for instance using a palette of 256 colours, but were pretty large. JPEG is a lossy compression format which reduces the file size by representing blocks of 8x8 pixels in the most optimal way, removing information in the process. Lossy compression is able to obtain results indistinguishable from lossless compression but at 1/10th of the size (Sneyers, 2023). Of course the loss of information comes at a price, JPEG's suffer from generation loss, meaning quality degrades when compressing already compressed images. JPEG comes with settings representing a trade-off between quality and file size which at the lowest quality can lead to visible compression artefacts. JPEG led to a revolution in digital photography, which until then remained pretty impractical due to large file sizes and limited storage. Even though an individual digital photo has a smaller impact than an analogue one, the enormous growth in the production of digital photos, and the related devices and infrastructures through which they circulate, is a clear example of how gains in efficiency lead to an overall increase in resource use, the Jevons paradox again. This short history also shows how many 'shades' of small there are between the 12kB of *Les Horribles Cernettes* and the 5000 kB (5MB) of an average high quality digital photograph today (Sneyers, 2023). Plenty of room for experimentation with alternatives to bandwidth imperialism and maximalist techno-aesthetics, which are part of the economy of growth and overconsumption that drives climate change.

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[18] The size of information is hard to get a feel for, and since I am now speaking mostly in terms of kilobytes—a size that lost currency due to inflation—I'll give some indication of scale. The smallest unit of information in computing is the bit, a binary digit that has two states, on or off, usually represented by 1 or 0, true or false, + or -. 8 bits is one byte. Computers (and therefore programmers) then split with the rest of mankind and count in base 2 (binary) by multiplying with 1024 to reach 1 KiB and 1024x1024 to reach 1 MiB. The rest of mankind uses base 10 (decimal), 1000 bytes is 1 kilobyte (kB) and 1000 kB is one Megabyte (MB).

The Small File Photo Festival

> "We are looking for small file photographs! We call to overcome the high-resolution regime and propose that small is beautiful, exciting and relevant!" (The Photographers' Gallery, 2022)

> "Small files and low resolutions can help curb the increasing global CO_2 emissions from digital media infrastructures, while nurturing a fertile and accessible visual culture. Questioning the endless growth of higher and higher resolutions, we want to continue supporting and sharing the joy that tiny images, fat pixels and efficient compression tools have provided to the history of image-making." (The Photographers' Gallery, 2022)

The open call for the Small File Photo Festival had three main categories, each meant to stimulate a different type of experimentation. The first was *Dress to Compress*, calling for photographs of up to 100Kb making use of different methods of compression. Participants in this category were asked to provide a description of the tools that were used and the steps taken to compress it so the jury could appreciate this often hidden layer of a work. A minimum of 100x100 pixels as dimension was recommended. The second category was *Small is Beautiful*, intended for photographs experimenting with different devices which take small photographs by default, such as an old digital point and shoot, a vintage smartphone or a Gameboy camera.[19] Participants were asked to provide a description of the device that was used so the jury could consider this. The last category was *Show Me The Pixels*, inviting images of up to 100Kb using any visually striking compression process that features compression artefacts as aesthetic, from dither-punk, to pixel art, including any other image processing effects such as glitching, ASCII or halftone. Even though the motivation behind the festival was serious, the event was not meant to be a heavy hearted and serious competition but a joyful celebration of the small image in all its shapes and forms. The call, the categories and the jury process were therefore not a strict and rigorous procedure but a humorous and rebellious act, celebrating what are generally considered 'poor' or low quality photographs, in the heart of a photography institution.[20]

The call went live on Wednesday November 9 2022 and closed on Wednesday January 4 2023. A total of 437 works were submitted. I was part of the jury, next to artist and curator Antonio Roberts, who has developed work in the fields of glitch art and live coding, exploring and revealing the limitations and creative potential of technology. The third jury member was artist and researcher Roel Roscam Abbing, one of the designers behind *Low-Tech Magazine*'s solar powered website, whose practice explores the politics and materiality of technology, network infrastructure and do-it-yourself approaches. The fourth jury member was conceptual photographer Clare Strand, whose work investigates photography's origins, uses and limitations. We (the team) were very happy and slightly overwhelmed with the amount of submissions and incredibly impressed with the quality and diversity of the works. The first step of the festival's jury process was bringing the list down from 437 to about 100.[21] This longlist was studied by all jury members, who each picked ten works to create a shortlist of about 40 works. The shortlist is exhibited online and from it the winners of the 6 awards were selected. The award ceremony was held at the end of the SFPF, January 28 2023.

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[19] Nintendo produced the Game Boy Camera, an accessory to the Nintendo Game Boy game console, between 1998 and 2002. The camera could take 128 by 112 pixels, grayscale digital images. It was one of the earliest consumer digital cameras.

[20] In line with the unrigorous nature of the event, the team decided it would invent other categories if photos were submitted that didn't fit the three pre-existing ones but that were prize winners on their own terms. The call mentioned potential additional categories such as 256 shades of grey, drippy palettes, chic-dither-punk, pixel perfect, tiny binary, more-than-a-pixel, and more.

[21] I want to thank Sam Mercer for this incredibly difficult and time consuming task.

A wide variety of methods were used to create small file photos. To give an idea of the types of methods, there were 13 photos taken with an analog camera which were later digitised, 5 were based on film stills, 13 used old point and shoot cameras, 8 used an old smartphone, 3 used a Gameboy camera, and then there were photos taken with a spycam, wildlife cam, web cam, an MRI scanner and a floppy disk camera. There were a few screenshots, in-game photography and photos made using a scanner. There were 42 works that listed a post-processing software such as Gimp, Krita, Lightroom or Photoshop, used for resizing, dithering, 'save for web', colour profile adjustments and unspecified forms of compression. Six artists used a phone application such as Retroboy, 10 used an online compression tool such as Dither it!, 5 used the compression of online platforms such as Facebook or Instagram and 4 wrote a custom script. Another post-processing method was datamoshing, which is done by manually editing a compressed file to create glitches. Two artists turned a photo into ASCII art, making use of plain text characters to constitute a picture. Many combined multiple methods. A wealth of different methods resulted in an amazing diversity of photographs. I will discuss four works and methods in more detail, exploring how these challenge bandwidth imperialism and give expression to different, visual, definitions of technology.[22]

The *MAVICAZINE* series (2022) by photographer Renaat Nijs won the award in the category *Show Me The Pixels.* Together with Raf Horemans, Nijs publishes MAVICAZINE, an ode, not just to the first digital Mavica series, but to all early digital cameras. This series was part of the project, which aims to demonstrate how low resolution digital photography, even though often frowned upon, can be mesmerising (Nijs, 2023). The photos were taken with a Sony Mavica MVC-FD7 Floppy Disk camera from 1997. The FD7, recording two VGA interlaced fields in 640×480 pixel JPGs, takes 10 seconds to write a 0.3 megapixel, 8 bit photo onto a floppy disk. Nijs glitched the image by physically abusing the floppy-drives with a 13" claw hammer during the writing of the file, a very unpredictable, trial and error process; highly inefficient but according to Nijs, it sounds

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[22] The online exhibition can be visited at this address: https://unthinking.photography/projects/smallfile/ which I did not want to hide in the reference section. The online exhibition website idea was developed by Sam Mercer. The site was developed by Tom Sansome and Mateus Domingos. The website reflects the concept of the SFPF. Images are not loaded unless you click on their title. The visitor is made aware of their weight which is listed next to the title. The gallery has no menus or navigation other than a horizontal scrollbar. It is light and gorgeous.

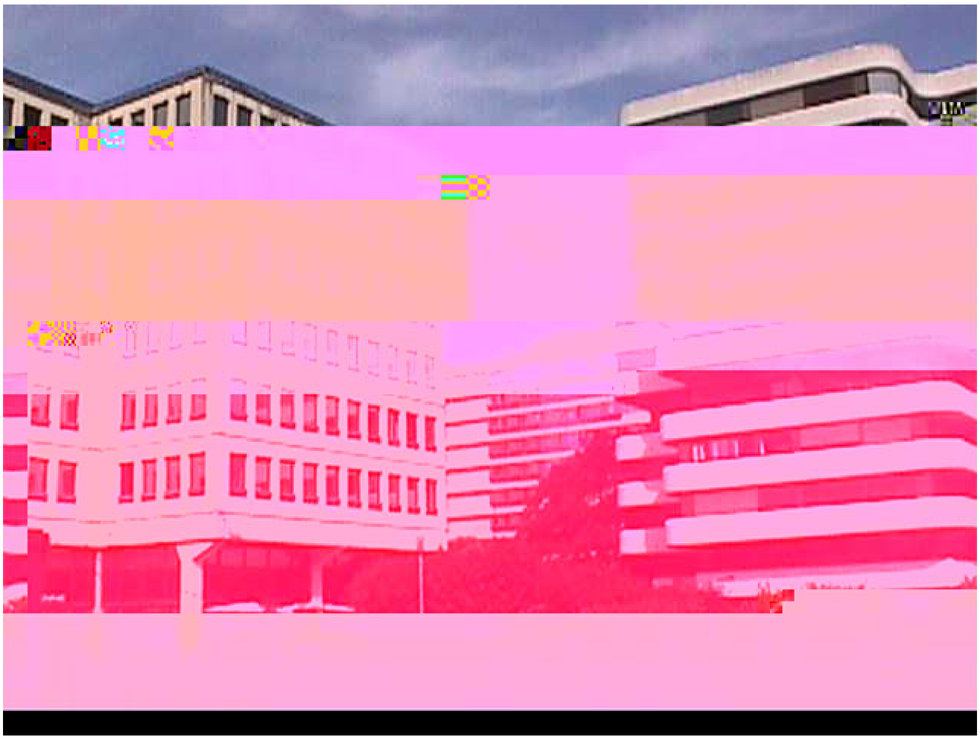

Figure 5.2: Nijs, R. (2022) *GLITCH01-BORDEAUX_MAVICAZINE* [Photograph]. © 2022 MAVICAZINE - RENAAT NIJS. Courtesy Renaat Nijs.

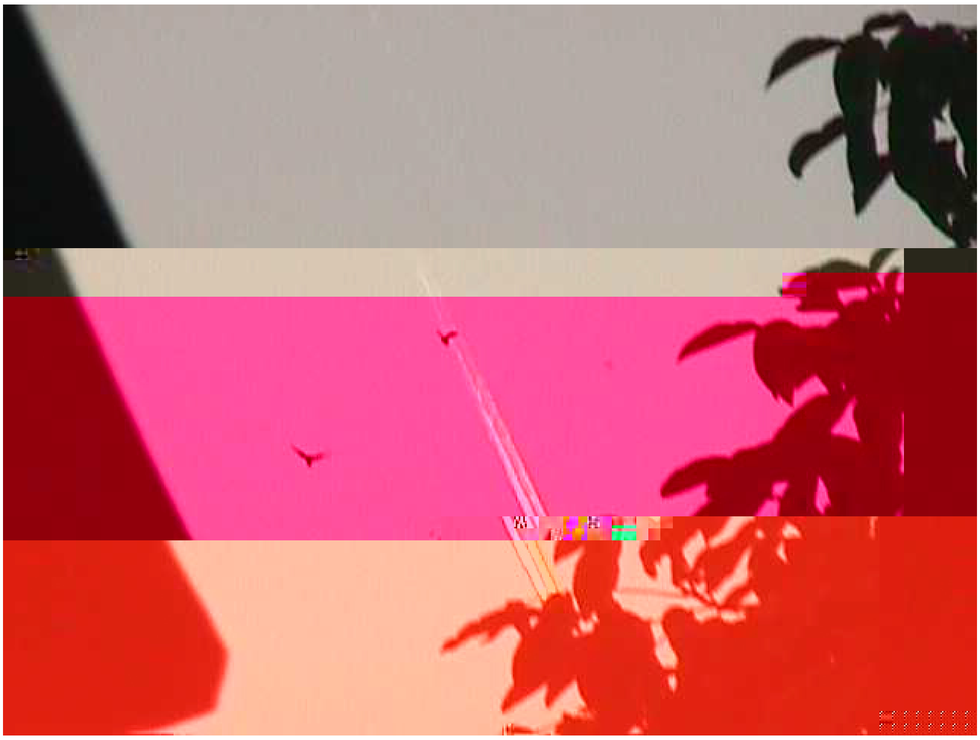

Figure 5.3: Nijs, R. (2022) *GLITCH07_BIRDS_MAVICAZINE* [Photograph]. © 2022 MAVICAZINE - RENAAT NIJS. Courtesy Renaat Nijs.

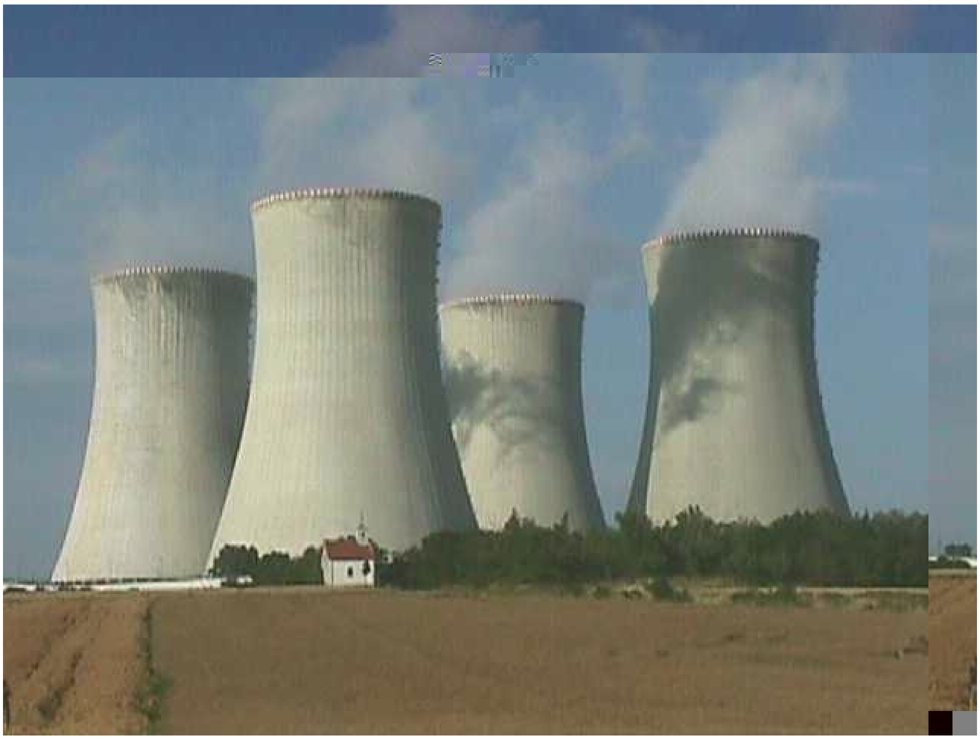

Figure 5.4: Nijs, R. (2022) *GLITCH09_CHAPEL_MAVICAZINE* [Photograph]. © 2022 MAVICAZINE - RENAAT NIJS. Courtesy Renaat Nijs.

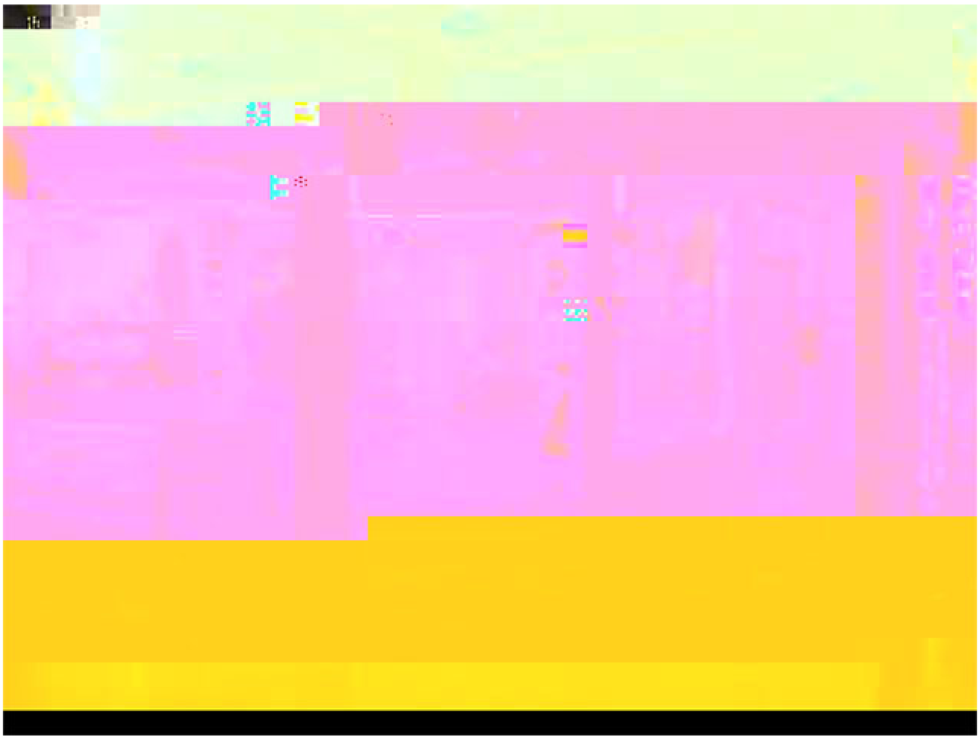

Figure 5.5: Nijs, R. (2022) *GLITCH02_WAREVRIENDEN_MAVICAZINE* [Photograph]. © 2022 MAVICAZINE - RENAAT NIJS. Courtesy Renaat Nijs.

great. He calls this process ‘analogue editing’. The photos weigh 64 kB on average. The series challenges bandwidth imperialism and dominant definitions of technology by emphasising (with brute force) the materiality of the digital. Rather than betting on ephemeralisation, doing more and more with less and less, it does less and less with very little. It makes the material nature of the digital photo tangible by literally taking a hammer to it, erasing and distorting parts of it. Next to this, it challenges maximalist techno-aesthetics, which aims for ‘indistinguishable from real’ high resolutions and effects, by embracing low resolution’s simplification of colours and shapes, and the unpredictability of the process of ‘analog editing’ and its introduction of abstract elements in the image, creating what seems close to a blend of photography and graphic design, an ironic but beautiful clash between modernist themes and technological glitches and failure.

Gameboy Ansel Adams – Snake River Overlook (2022) by photographer and computational linguist Sofia Lee is a dithered and modified version of Ansel Adams’ *The Tetons and the Snake River* (1942).[23] The image was cropped and resized to 160x144 pixels in Photoshop, after which it was exported as GIF using legacy web export settings with a Game Boy palette and pattern dithering enabled. The artist saw similarities in dithering spritework and Ansel Adams’ zone system and wanted to explore the potential for rich tonalities.[24] The jury was quite fascinated by this work, which seems to commit a type of aesthetic sacrilege, as Clare Strand observed; Ansel Adams is the master of the ‘fine art print’, obsessed with tonal and print perfection, and the fact that precisely *his* print was processed with one of the most heavy types of compression possible is quite a statement. The image weighs 4 kB. Ansel Adams (1902-1984), whose photos of national parks and work as an environmentalist helped expand the national park system in the US, never made the connection between electronics and environmental harm. In an interview from 1983 he was quite looking forward to extremely high resolutions:

> “There’s no end in sight. Electronic photography will soon be superior to

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[23] Sofia Lee is one of the founders of digicam.love, a community founded in 2018 to promote photography done with old digital cameras. During the SFPF she hosted a retro digital camera photowalk in the streets of central London. I joined the walk with an old Vtech Kidizoom toy camera and spend some time with fellow vintage digital camera enthusiasts on the streets of Soho.

[24] The zone system is a system photographers and film makers can use to optimise film exposure. The system was developed by Ansel Adams and Fred Archer around 1940.

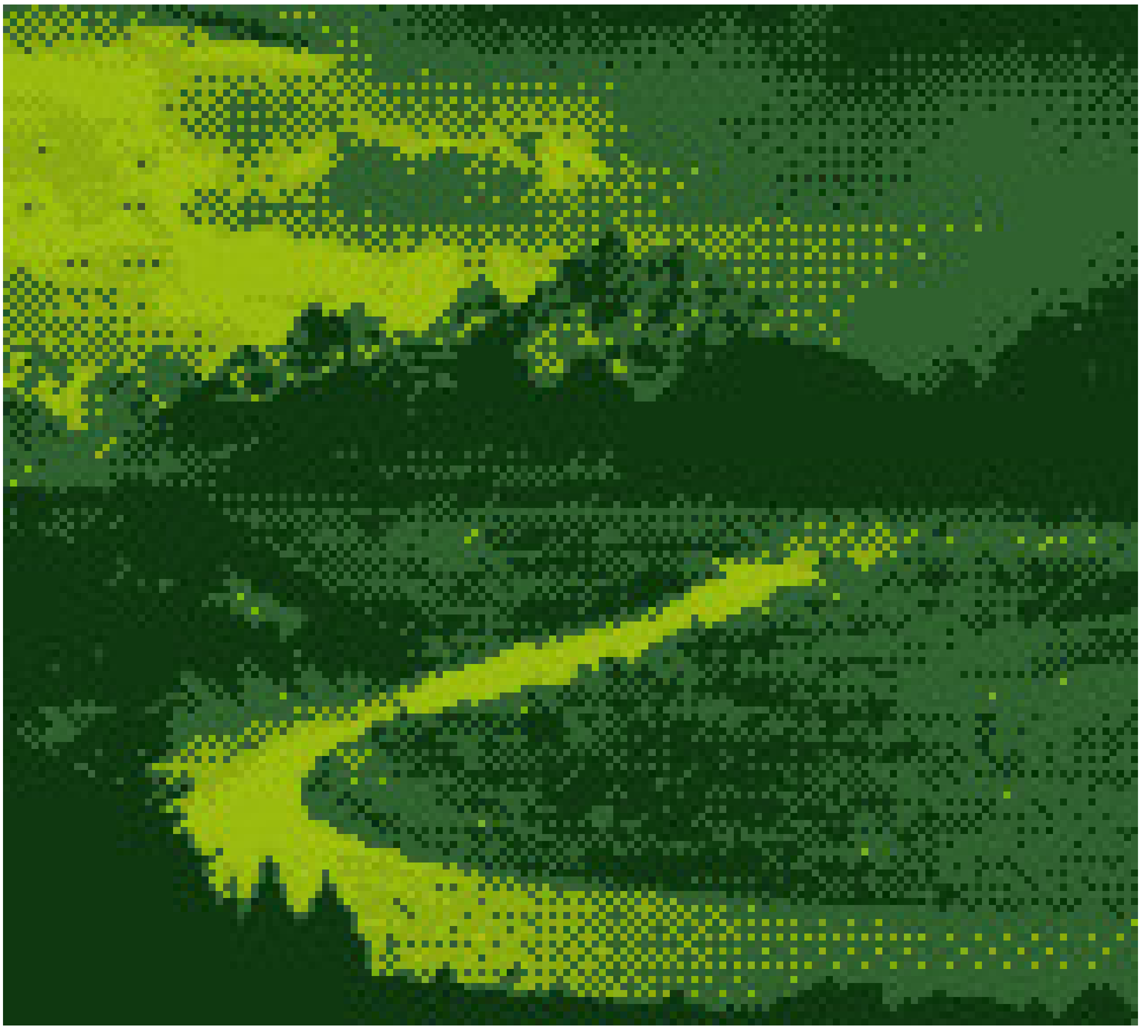

Figure 5.6: Lee, S. (2022) *GameBoy Ansel Adams - Snake River Overlook* [Photograph]. © 2022. Courtesy Sofia Lee.

> anything we have now. The first advance will be the exploration of existing negatives. I believe the electronic processes will enhance them. I could get superior prints from my negatives using electronics. Then the time will come when you will be able to make the entire photograph electronically. With the extremely high resolution and the enormous control you can get from electronics, the results will be fantastic. I wish I were young again!" (Ansel Adams in Sheff and Adams, 1983)

Lee's work does not commit sacrilege, it is a confrontation with the old conservationist environmentalism of Adams, which seeks to preserve nature in designated natural parks, hoping to protect it from human intervention. Like his environmentalism, his photography also fixes, separates and conserves: it requires sharpness and amazing detail and it lends its strength from the mesmerising stillness, depth and detail of immense landscapes, untouched and uninhabited, frozen in time. Lee's work doesn't bet on separating nature from society, and seems to hint at how the Tetons and the Snake River, no matter their status as national park, are penetrated by micro-plastics and PFAS. Lee's work shows a different relation of photography and environmentalism, one in which the medium reflects the message.[25] It engages with the inseparability of nature and culture and with technology's environmental impact, including the medium and distribution channels of a work of art. *The Tetons and the Snake River*, shows an untouched nature and is itself untouched and conserved in museums and archives. It was never meant to travel over networks or be multiplied on storage media across the globe. *Gameboy Ansel Adams – Snake River Overlook* shows nature distorted by technology, it can travel lightly to even the least networked areas of the globe and is an expression of its own entanglements with industrial capitalism. It isn't sacrilege, its a resistance and a redefinition of technology by expressing inseparability of nature and culture, at odds with soft technology's ecomodernism. Where Lee challenges this separation by taking a claw hammer to a classic, photographer Nika Sandler does so through her choice of perspective.

My Nonhuman Friends (2021) is a photo series by photographer Nika Sandler. Two years

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[25] This is not to be confused with McLuhan's technological deterministic approach of media as 'the' message. The medium itself isn't attributed any agency, the choice of medium simply expresses the awareness the creator has of its materiality and environmental impact. The attention given to the medium becomes part of the artwork's message.

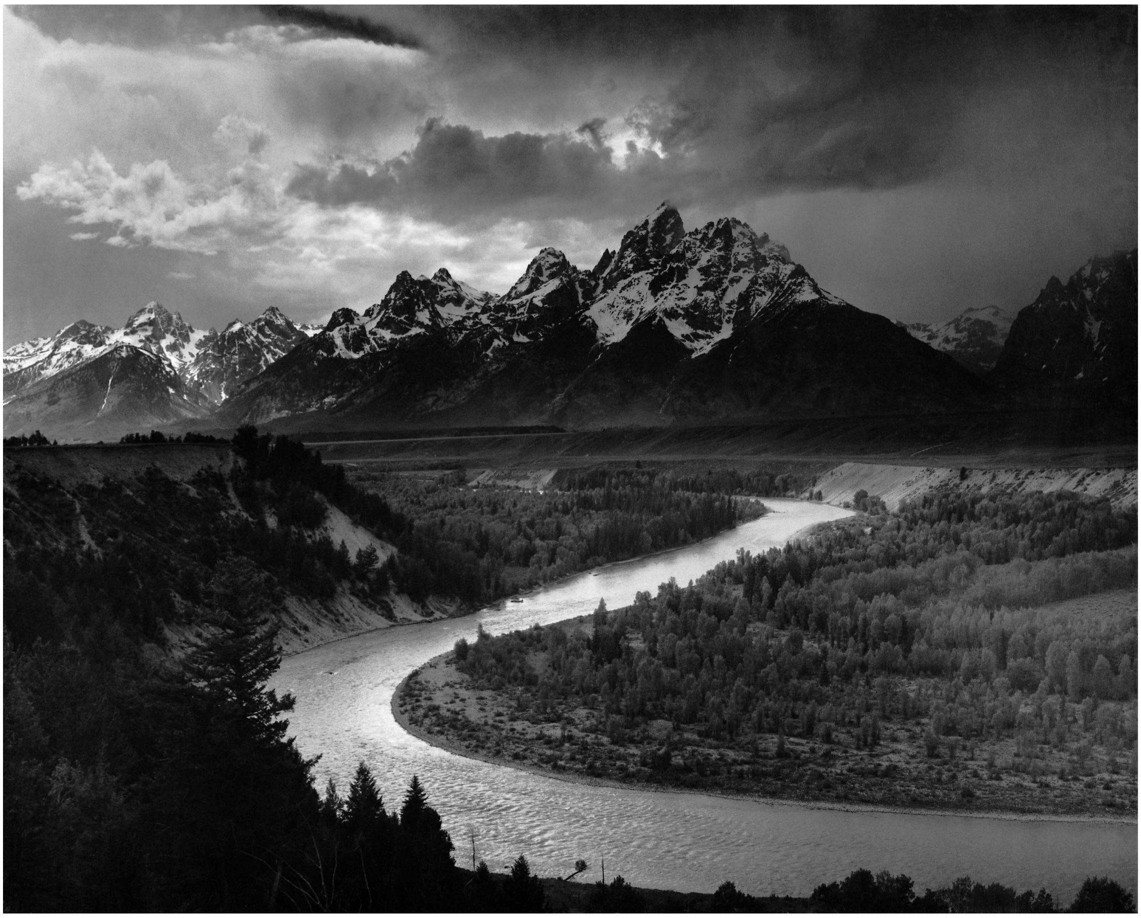

Figure 5.7: Adams, A. (1942) *The Tetons and the Snake River* [Photograph]. Public domain.

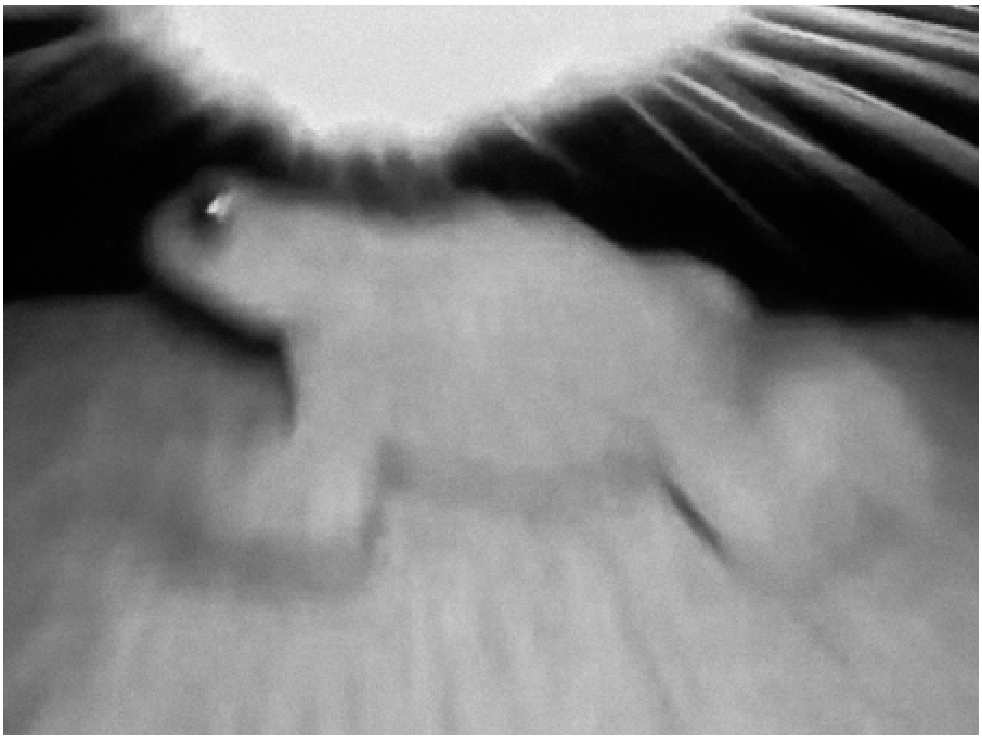

Figure 5.8: Sandler, N. (2021) *My Nonhuman Friends* [Photograph]. © 2021. Courtesy Nika Sandler.

Figure 5.9: Sandler, N. (2021) *My Nonhuman Friends* [Photograph]. © 2021. Courtesy Nika Sandler.

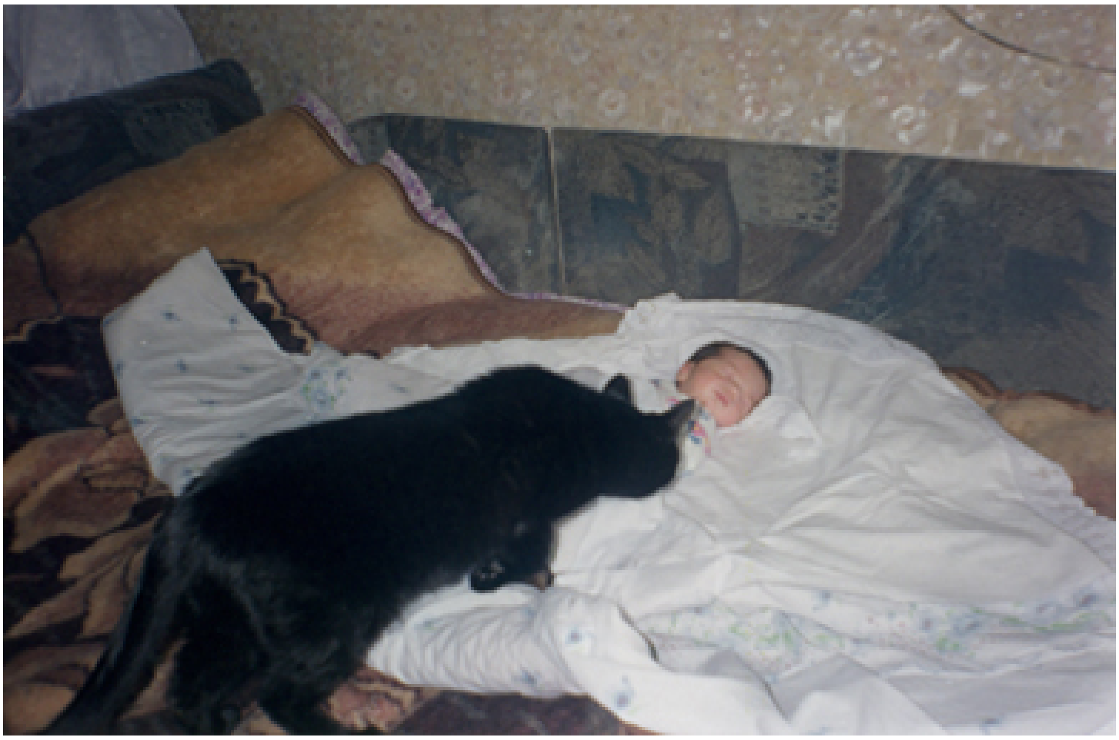

Figure 5.10: Sandler, N. (2021) *My Nonhuman Friends* [Photograph]. © 2021. Courtesy Nika Sandler.

Figure 5.11: Sandler, N. (2021) *My Nonhuman Friends* [Photograph]. © 2021. Courtesy Nika Sandler.

ago, she lost a close feline friend. This triggered her to immerse herself in the memories of cats and reflect on their impact on her life. She has always been surrounded by them and their friendship began at a very young age. She tried to look at and recall the smallest details in a catlike, far-sighted way, creating still lives with objects that remember the touches and smell of her friends. Some of the photos are taken from a cat's perspective, using a small camera attached to a cat's collar, giving a glimpse of how they see the world. Other photos are archival ones of the cats in her life, taken by her, and of her, as a child. The series gives shape to a deeply felt empathy and connection explored through photography. *My Nonhuman Friends* won an award in a category created especially for this series, *Posthuman Postphotography*. The five photos have an average weight of 100 kB. Sandler's work challenges hegemonic definitions of technology by using 'poor' images, low resolution ones, taken with old or very limited cameras, shifting perspective to give expression, and deepen a connection, to the non-human. Sandler's work matches Ingrid Hoelzl and Remi Marie's (2022) concept of the 'common image'. Hoelzl and Marie (2022, p. 11) describe the perspectival image as the foundation of humanist ideology, "which located *Homo sapiens* at the center of an inanimate, dumbfounded 'world' in need of human ruling [...] a foundation of the ideology of rationality, progress, and human exceptionalism [...]". In its stead, they propose a 'common image', which doesn't place humans apart from the world and doesn't count on human ingenuity to 'fix' climate change, but which is based on more humble world views, a being-in-relation, a multisensory perception that transcends species-bound ways of living. They advocate otherness as a common ground for a larger than human communism. Sandler's work takes steps towards such a world view, out of a profoundly felt love and in search of the common. In the last work this shift in perspective merges with the choice of medium.

William J. Brooks' works *Audible Photographs* (2022) are a series of 35mm photographs encoded in radio waves using slow-scan television (SSTV), an image transmission method in which an image is translated into radio signal which can be decoded back into its photographic form. It is a very slow transmission method. It can take up to a few minutes to transmit one still image. It was used as a method to disseminate photographic information during early space exploration. Each recording can be decoded through audible reception using an SSTV app on any mobile phone or computer. Each attempt to decode the photo from the audio results in a slightly different image due to minute variations in audible reception. Ambient noise often influences the resulting decoded image. The images transmitted and decoded are from the Preseli Hills, Pembrokeshire, Wales. The photos weigh 11 kB on average and are 160x128 pixels. *Audible Photographs* won the award in the *What's The Frequency Kenneth* category, especially created for this series. This work's choice of transmission medium takes us back to the start of this dissertation, to the first colour photo of the whole Earth from space, the image that would change the world. This photo was taken by the Applications Technology Satellite 3, a NASA weather and communications satellite, and transmitted via radio just like *Audible Photographs*.

Stewart Brand became convinced that if people ever saw an image of the Earth from space–whole, tiny and adrift—it would change people's perspective on everything. This idea was inspired by something Buckminster Fuller said in a lecture Brand attended, about how people's misbehaviour towards the planet was rooted in the way they perceived the Earth, from their perspective, as flat and infinite. However close this seems to Hoelzl and Marie's observation about the perspectival image, it didn't lead Fuller nor Brand to let go of the humanist ideal of mastery over nature. Brand's choice for the perspective of Earth from space can be seen as similar to what Haraway (1988, p. 581) has called the 'god trick', of seeing everything from nowhere, an unaccountable and disembodied perspective, distancing the knowing subject "from everybody and everything in the interests of unfettered power." Both Brooks' photos and the first image of the whole Earth are small images in terms of file size, but where the latter puts the 'god trick' into technologically enabled practice, the former takes an embodied and situated perspective that expresses an accountability towards what is seen through its choice of an old transmission method. Brook's series challenges the separation of nature and culture, idea and medium, by taking a grounded perspective and allowing the medium to be permeated by the world around, the ambient noises surrounding the receiver.

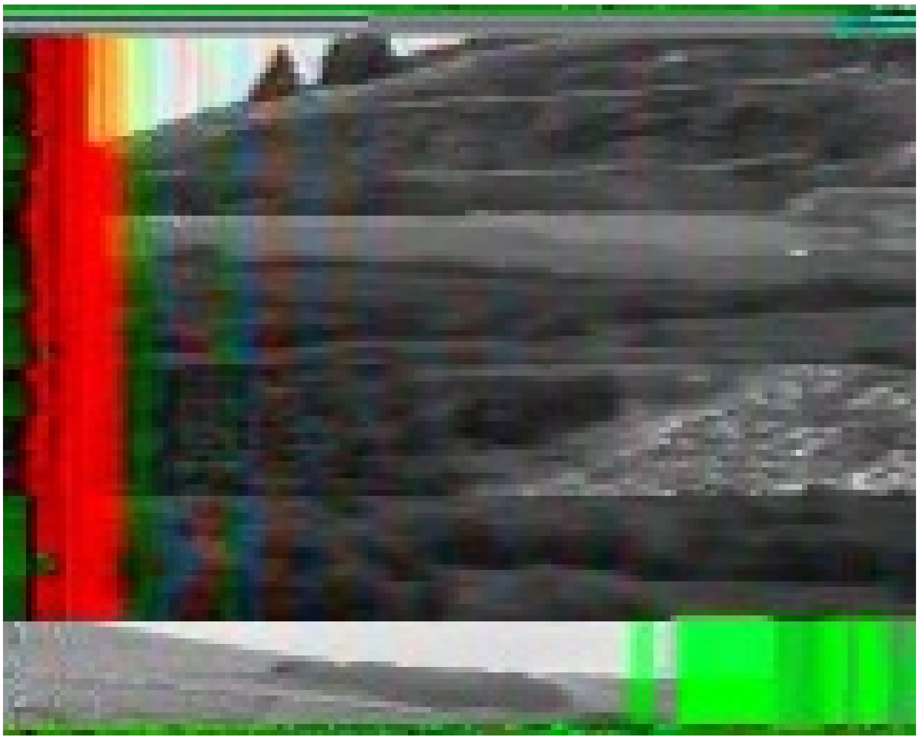

Figure 5.12: Brooks, W.J. (2022) *Audible Photographs* [Photograph]. © 2022, CC BY-NC-ND 4.0. Courtesy William J. Brooks.

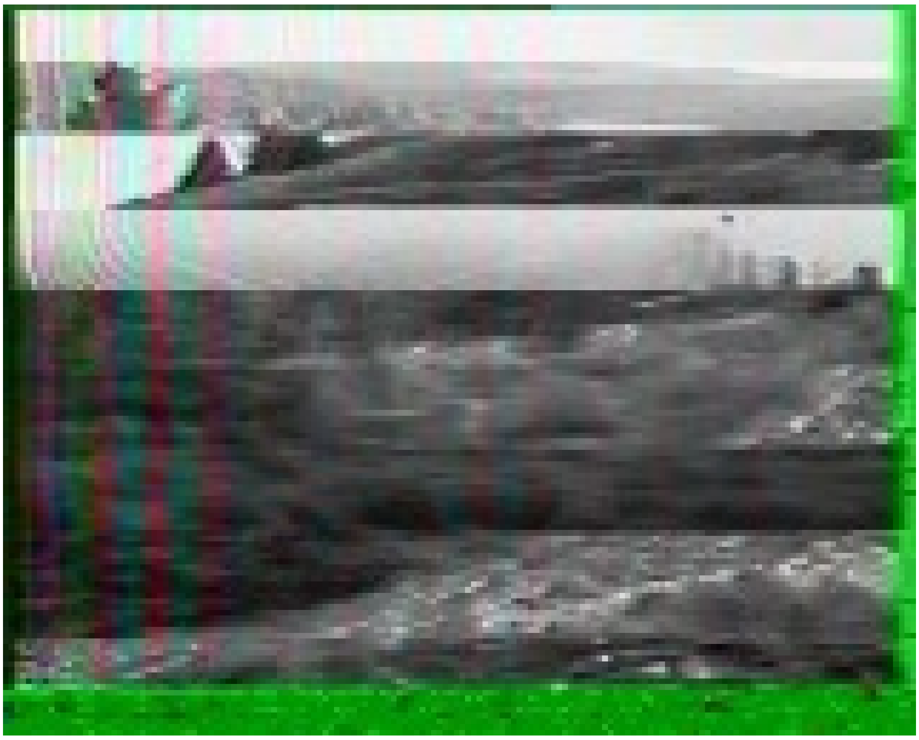

Figure 5.13: Brooks, W.J. (2022) *Audible Photographs* [Photograph]. © 2022, CC BY-NC-ND 4.0. Courtesy William J. Brooks.

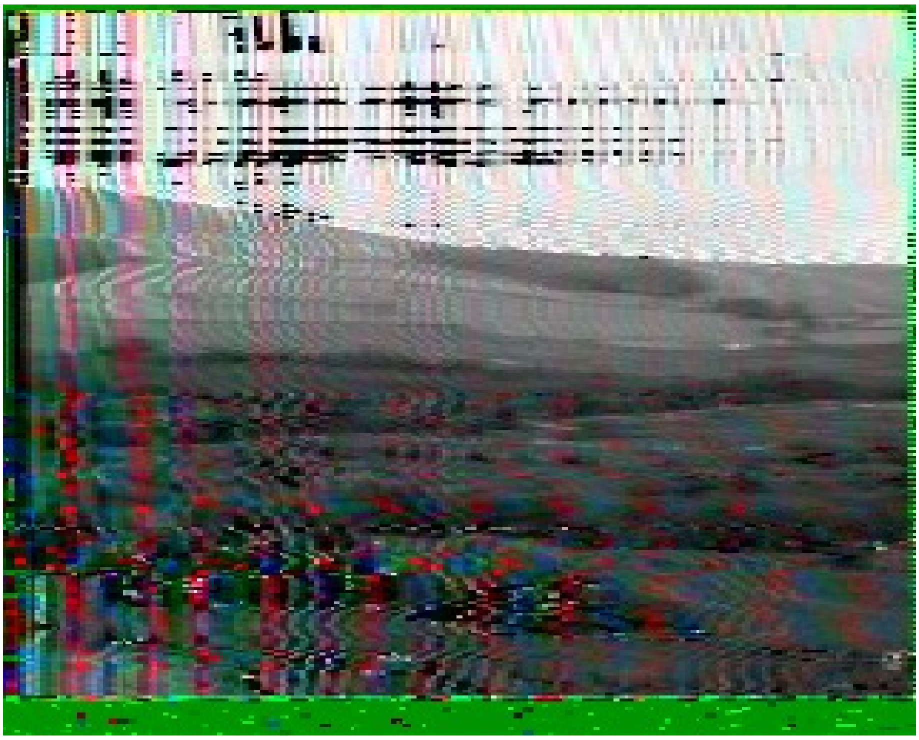

Figure 5.14: Brooks, W.J. (2022) *Audible Photographs* [Photograph]. © 2022, CC BY-NC-ND 4.0. Courtesy William J. Brooks.

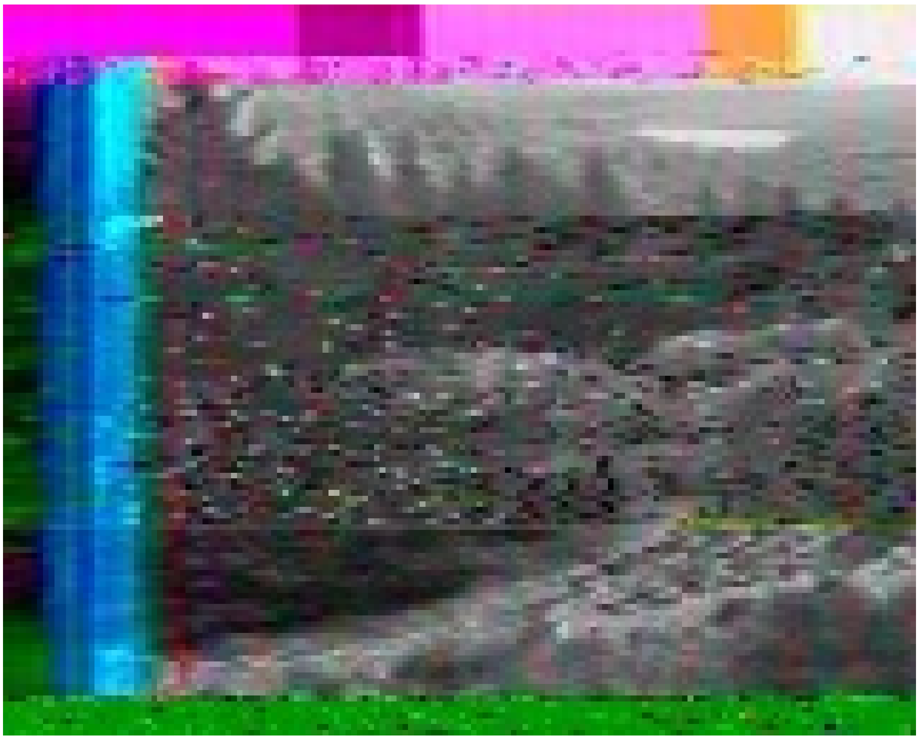

Figure 5.15: Brooks, W.J. (2022) *Audible Photographs* [Photograph]. © 2022, CC BY-NC-ND 4.0. Courtesy William J. Brooks.

In defense of the small image

> "We are demanding—unleash creative r/evolution! We are demanding—destroy the large-file clichés of thinking that prevent us from imaging a world otherwise!" (Marks *et al.*, 2023)

The SFPF aimed at celebrating and advocating for alternatives to high tech photo-realistic aesthetics traditionally linked to notions of truth and objectivity. This isn't a critique of the institution of photography, but a call for critical engagement with the materiality of digital photography. This research project is developed in collaboration with the Digital Programme at TPG, and as discussed in the introduction, it inherits many of its ambitions. The Digital Programme's launch was motivated by the need of TPG to 'unthink' photography, as it was confronted with both theoretical and practical problems posed by digital technology, resulting in dramatic shifts in the digital image as it became increasingly screen-based and networked (Sluis, 2012). Aligned with the goals of the Digital Programme's first exhibition, dedicated to the animated GIF, with the goal to disrupt expectations about screens, to challenge the fetishisation of resolution and image quality, and to explore different economies of the image—one in which value is based on mass circulation rather than uniqueness—this research project aimed to contribute another layer to the Digital Programme's critical engagement with the networked image (Sluis, 2012). It was sparked by the question of how this mass circulation of the networked image, which is today increasingly absorbed by the fetishisation of resolution, affects the environment. The project aimed at conversation with photographers, developers, artists and activists about this question. The SFPF became a productive environment to realise this.

The SFPF aimed to encourage experimentation with small file sizes and their specific visual qualities. While listening to each artist's short acceptance speech at the award ceremony the 28th of January 2023, the idea that small file photography is part of scarcity or austerity aesthetics seemed outrageous. So did the idea that using old cameras is simply nostalgic. These images didn't anticipate changing the world, they tried hard not to change it too much for the worse by being small. Each expressed an awareness of its materiality and of the interrelations between the position of the photographer, the digital artefact and the world depicted by it. Each photograph expressed different challenges to maximalist techno-aesthetics as well as to bandwidth imperialism.[26] While researching the idea for the festival, I encountered two theories of smallness in relation to digital imagery, connecting compression, digital images and ethics in ways that resonated with the SFPF. I will discuss Hito Steyerl's concept of the poor image and Sean Cubitt's eco-political aesthetics to situate the small file aesthetics explored during the festival. Are small images poor and is compression oppression?

The ideas behind the SFPF are strongly connected to the ideas put forward in Steyerl's *In defense of the poor image*, which articulates the ambiguous but politically charged potential of low resolution images (Steyerl, 2009). Her discussion of the poor image resonates because she situates it in its wider context of information capitalism and neoliberalised cultural production and consumption patterns. She describes resolution as a class position. The poor image is the "proletarian of the class society of appearances": low resolution, bad quality, a copy of a copy. It "mocks the promises of digital technology" (Steyerl, 2009). She depicts it as a popular image, easily produced and consumed by many, gaining in speed as it looses matter. The poor image is both an outcast as well as perfectly assimilated by information capitalism, which feeds on quick consumption rather than slow contemplation. Cinema and photography are both embedded in capitalist (cultural) production, the cult of individual (male) genius and the conservative emphasis on the original version (Steyerl, 2009). She argues for breaking cinema out of the gate kept realm of cultural production as supported by nation states. The SFPF broadens this to photography, as I discussed in relation to the work of Sofia Lee and Ansel Adams. The poor image proliferates outside of this elite position. Steyerl's defence builds upon Cuban filmmaker Juan García Espinosa's manifesto *For an Imperfect Cinema*, which calls for a cinema which blurs the lines between author and audience, producer and consumer, life and science, through a "resolutely compromised visuality" (Steyerl, 2009). The SFPF promotes an imperfect photography.

> "The poor image is no longer about the real thing—the originary original.

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[26] I use both terms side by side, because they each place emphasis on a different aspect of the regime of high resolution, high bandwidth digital imagery. Bandwidth imperialism places the concern for exclusions from the circulation of cultural works in less wired countries, and the push for global expansion of high speed networks front and centre. Maximalist techno-aesthetics emphasises a specific notion of beauty and its embedding in industrial capitalist upgrade-or-die cycles.

> Instead, it is about its own real conditions of existence: about swarm circulation, digital dispersion, fractured and flexible temporalities. It is about defiance and appropriation just as it is about conformism and exploitation." (Steyerl, 2009)

This break with high resolution photorealism is an other type of realism, one concerned with conditions of existence rather than representation, another strong connection between Steyerl's poor image and the SFPF. The poor image is real, but not in the sense of realistic representation or a unique original, but in its expression of its real conditions of existence within networks of production, circulation and consumption. The small image is the poor image's sibling, more attuned to the environmental aspect of its conditions of existence. Rather than an accountability in terms of truthful representation, it places its own materiality in relation to an accountability towards the world it depicts. The small image is deliberately small, not only to diminish its environmental impact, but also to enlarge its reach. This brings me to a final resonance with Steyerl's essay, which connects low resolution imagery to a potential of connecting audiences. She gives this potential a political charge. The poor image is a resistance against the fetish value of high resolution, but because of its fast and promiscuous distribution across the globe it is simultaneously perfectly assimilated into information capitalism's quick and superficial consumption patterns. This allows for an alternative economy of images to flourish, where marginalised content reaches dispersed worldwide audiences. Steyerl's poor image loses the aura of 'the original' but gains a new one.[27] Its existence outside the curated cultural public sphere supported by nation states gives it a new political force, it creates a 'visual bond' as Steyerl borrows from Soviet filmmaker Dziga Vertov, connecting audiences across the world. (Steyerl, 2009). Similarly, the small image aims to take less high bandwidth areas of the globe as point of reference, creating a visual bond that strengthens resistance against bandwidth imperialism, and with its loss of mass, gains material awareness and solidarity.

Small file photography visually redefines dominant definitions of technology through these three reframings of digital photography: low resolution by choice as a resistance against the promises of digital technology; a situated and partial perspective, accountable to the world depicted; and a commitment to connecting dispersed audiences. I would like to discuss another redefinition, in the realm of Stengers and Pignarre's yearning, of collective fabrication of alternatives, in more detail through Cubitt's concept of eco-political aesthetics, described in *Finite Media: Environmental Implications of Digital Technologies* as a communication of and through difference, opposing the universalising effects of market capitalism, and integrating the non-human within mediations (Cubitt, 2017). This concept resonates with the small file photograph's embrace of diversity and an acknowledgement of its own materiality, weight and its resulting burden on the planet and all its inhabitants. Cubitt further defines eco-political aesthetics as 'media as poetics', capable of imagining a different, 'unthinkable' future. "If politics is the art of the possible, eco-political aesthetics is the art of the impossible." (Cubitt, 2017, p. 186). However aligned this seems with the small image, the connection Cubitt draws between this art of the impossible and lossy compression, the technology making the vast majority of small images possible, couldn't be further removed.

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[27] Here Steyerl builds upon the work of philosopher Walter Benjamin (2008), who unpacks this 'aura' of the unique and original work of art, and the effect of mechanical reproduction removing this aura, in *The Work of Art in the Age of its Technological Reproducibility.* The poor image is more democratic because of this broad circulation, and politicises art rather than aestheticising politics (Benjamin, 2008; Steyerl, 2009).

Cubitt uses the decay of the film *The Kelly Gang* by Charles Tait (1906) as an example of how media and mediation cannot be separated from their environmental impacts. Because of this, it is not economical, technological, political or social responses, but media and mediation that could lead us out of the environmental crisis (Cubitt, 2017, p. p9). Tait's film has decayed considerably, and only a few minutes of heavily damaged (and more recently also heavily compressed) material remain. The archival process consisted of digitising the deteriorating film and in the process, cleaning it. This process actually introduced new artefacts, from the cleaning and compression into MPEG-4 video. This morphing of the film, its chemical and digital afterlife, is for Cubitt a microcosm of the potential of media and mediation as tools for creating futures that are not repetitions of the dystopic now, since they cannot be separated from their environmental impacts and their own (decaying) materiality. For Cubitt, the remaining footage of *The Kelly Gang* is a departure from the 'original sin' of things having to remain the same, which stems, according to Cubitt, from the privilege granted to communication, severing humans from their environment and thereby placing them into the separate domains of subject and object.

For Cubitt, this severing turns the environment (and the species, materials and people part of this ‘otherness’) into something separate, without agency, something to be acted upon. Ecofeminist and Marxist feminist scholars, Salleh, Carolyn Merchant and Silvia Federici among others, have argued that this othering of nature, BIPOC and women under patriarchal colonial capitalism, has been the root of the environmental crisis for decades. They do not look to communication as ‘original sin’ but to a historical development in which nature was reframed as externality to be dominated by man through science and technology. This development was the result of capitalism’s need for primitive accumulation, enclosure of the commons, forcing people into wage labour, to the ‘othered’ labour of BIPOC and women (Salleh, 1997; Federici, 2004; B. Merchant, 2019). I cannot do justice to this immense body of theory and activism in this chapter, but need to bring presence to it because of its absence in Cubitt’s writing, which traces the cause of this othering to a severance of humans from ‘the environment’, without interrogating how some humans became part of this ‘otherness’, while others did not. He blames abstractions rather than the historical development of interconnected oppressions related to class and privilege within an extractivist economic system. Cubitt’s take on eco-political aesthetics as opening to other futures resonates with the SFPF, but his tracing of the cause of environmental collapse to communication does not.

A final redefinition of technology by the small image deserves attention: it takes a situated approach to knowledge production and avoids generalisations and universal solutions. I’d like to turn to Cubitt’s discussion of the Green MPEG compression format to clarify this position. His exploration clearly demonstrates how aiming for efficiency will not curb the energy and resource demands of the networked image. He illustrates how engineering for efficiency in the context of a proprietary standard such as MPEG benefits corporations from the US and to a lesser extent Europe, and places a prohibitive financial burden, through patents and licenses, on companies from developing economies. It’s ‘efficiency’ is not there to save the planet, but to make sure ultra high definition video doesn’t congest the network. It’s directly aimed at consumerism in wealthy nations. This is exemplified by the pushes for 4k and 6k resolutions, even though at 1080p (HD) screens we’ve reached the limits of human perception. This triggers a domino effect with compression standard's upgrades leading to software and hardware upgrades (screens and phones), which greatly exacerbate waste and resource use (Cubitt, 2017, p. 146). Following this story, curbing demand rather than chasing efficiency is once again a more promising path.

Cubitt then leaves socio-economic analysis and returns to the primacy of media and communication when he describes compression and standardisation as governance of seeing: "MPEG teaches us to fail to see" (Cubitt, 2017, p. 147). He interprets MPEG's reduction of detail in video backgrounds as an exclusion of nature because it is not deemed of sufficient importance. He even sees it as coloniality by other means, because standards are forced upon people who then have no other choice but to use these to communicate their culture. His negative take on compression standards as producing a failure to see, as well as standing in the way of communicating in diverse ways, ignores the ways in which high resolutions and uncompressed images could be accused of the same, and by being so heavy on bandwidth, actually exclude whole populations in less networked places of participating in and producing such material.[28] Generalising about standards, however funny that sounds, is not helpful in thinking through decolonial and ecological ways of transmitting knowledge and culture. Compression can express treading more lightly and leaving a smaller footprint, while also remaining accessible to those in less wired locations on the planet.

The small image takes a situated approach to knowledge production and avoids universal solutions, meaning it is not about format wars, aiming at one codec to rule them all, but about inventive use of compression. The politics involved in compression standards, something Cubitt touches upon in his discussion of Green MPEG, are relevant to the discussion of small file aesthetics, because even though efficiency is not the solution, it can most certainly be an element alongside other measures. Gatekeepers such as the Moving Pictures Expert Group have a lot of influence in determining the direction of this whole chain of production and consumption, from image compression standards, through patents and royalties, to screens, cameras and phones. In the essay *History and environmental impact of digital image formats*, Jon Sneyers, co-developer of the JPEG XL format, describes how this new format suffered a massive setback due to what sounds like sabotage by engineers of a competing codec. Google develops and promotes WebP and AVIF, yet in March 2021 added experimental JPEG XL support to its Chrome browser. 'Experimental' meant that it was off by default, and had to be turned on by the user via a flag. This early try-out triggered interest in the format by others such as Adobe, Meta and Intel (Sneyers, 2023). The Chromium issue tracker contained the enthusiastic response by a Facebook developer:[29]

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[28] It is not within the scope of this section to dive into the impact of file compression standards on cultural heritage. For a detailed discussion of this in an Arab context, please see Marks' *Poor Images, Ad Hoc Archives, Artists' Rights: The Scrappy Beauties of Handmade Digital Culture*, in which she provides an analysis of the interplays between compression, uneven access to media technology and network connectivity and archiving. Rather than depicting compression as a failure to see, she discusses how compressed video emphasises and draws power from its material and social grounding and history (Marks, 2017). For an in-depth exploration of the history of video compression, please see Marek Jancovic's (2023) *A Media Epigraphy of Video Compression: Reading Traces of Decay*.

> "We're very exited about the potential of JPEG XL and once decoding support is available (without the need to use a flag to enable the feature on browser start) we're planning to start experiments serving JPEG XL images to users on desktop web." (Chromium, 2023)

In October 2022 however, tests of JPEG XL performed by AVIF engineers showed it underperformed compared to other codecs (Google, 2022). The tests appeared to be heavily biased. Google dropped JPEG XL support from Chrome, stating "There is not enough interest from the entire ecosystem to continue experimenting with JPEG XL", after which someone in the issue tracker commented:

> "Really? How did you gauge interest in a feature that effectively no one can use yet?" (Chromium, 2023)

Luckily, in June 2023, Apple announced support for JPEG-XL in all of its products, which might also tempt Google to bring back support. Until then, Google is effectively blocking adoption and acts as a gatekeeper while pushing for its own formats, WebP and AVIF, both of which are royalty-free but require quite some computing power to produce reduced storage and transfer size. JPEG and JPEG-XL require very little, and on top, storage and transfer costs for photos could both be reduced by 60%. It is very capable at delivering savings for high resolution imagery, and is also legacy friendly, meaning it can convert a JPEG into JPEG-XL without data loss, while still resulting in a 20% smaller file. JPEG-XL looks like a more accessible format, requiring less energy and computing power (and thus less hardware updates) to encode and decode images, but it is at the mercy of large corporations for an actual widespread adoption. Small file aesthetics are not about format wars, but about inventive use of compression. It connects the technical to the imaginative, to collective fabrication of—and experiments with—alternatives with a focus on means aligning with ends. This approach resonates with Suely Rolnik's words about political activism published in the 1986 edition of *Molecular Revolution in Brazil* (which also resonates with Cubitt's plea for difference against universalism, and poetics for other futures but is about another type of standardisation):

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[29] Google's proprietary Chrome browser is largely based on the code of Google's open source Chomium project. The discussion about JPEG XL took place on the chromium issue tracker.

"Strictly speaking, we cannot call it a 'protest'. It would be better to speak of an 'invention': they divest from the assembly lines of subjectivity, to invest others, creating other worlds inside this world. Whenever this happens, the principle of the current system, the standardisation of desire, suffers a blow" (Guattari and Rolnik, 2007, p. 16)

I realise this quote is quite out of context, but it expresses something profound about resistance on the micro level, micropolitics, in the case of Rolnik's preface to Guattari's *Molecular Revolution in Brazil* (2007), a resistance against standardised capitalistic subjectivities, a protest by unconsciouses, and simultaneously an invention of new subjectivities seeking allies, creating other worlds, reaching out. This invention creates a visual bond, a solidarity that the small image hopes to embody.[30]

Conclusion

This chapter revisited Brand's image that would change the world and proposed an alternative that breaks capitalist sorcery's most powerful spells and infernal alternatives: the image at the end of the world, a visual redefinition of technology. The magic words' efficiency and scale were interrogated and the potency of the small image as counter-magic, a politics expressed in imagery (Vertov's visual bond), was tested through a discussion of the Small File Photo Festival, celebrating the small image.

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[30] The book is about micropolitics, strategies of desire in the social field, in the context of an explosion of social expression after the fall of Brazil's dictatorship. However remote this story is from mine, I see relevance in the way it connects micro and macro scales and new ways of organising with an emphasis on diversity: "creating worlds inside this world" (Guattari and Rolnik, 2007, p. 16).

At the start of the chapter, I discussed the two most powerful spells faced by all practices discussed in this dissertation, including small file photography: scale and efficiency. I discussed scale by answering the question of whether the positioning of the individual act against the systemic problem is an honest representation of the choices faced by activists. I revisited how each chapter has demonstrated that it is not that simple. Individual responsibility for systemic problems should be refused, yet combining prefigurative politics with strategic politics, without losing sight of the different scales at which problems are reproduced, pragmatically and experimentally performs other worlds. Demonstrating computing otherwise is not only possible but already exists in the testing of ideas in code, hardware and community organisation. I discussed efficiency and that on which it relies for its power, quantification, as evidence. Together, these two project an image of objective evaluation of the effectiveness of measures taken to lower the negative impact of IT. The insistence on efficiency and renewable energy keeps the issue of IT's negative environmental impact out of political decision making processes, an example of capitalist sorcery's system which depoliticises decision-making processes—a politics that kills politics. Efficiency by itself, as explored in chapter 1, is not a factor that diminishes resource use. I discussed how efficiency at the hardware level leads to bloat on the software side, and even though leaner software doesn't lead to more use of software, industry doesn't benefit from increased efficiency of consumer software and therefore it isn't pursued. Efficiency at the level of the networked image through lossy compression has suffered from the Jevons paradox: it made digital photography possible resulting in an explosion of production of digital photos and related devices and infrastructures through which they circulate, a clear example of how gains in efficiency lead to an overall increase in resource use.

No matter how powerful the spells of scale and efficiency, there is room for experimentation with alternatives to bandwidth imperialism and maximalist techno-aesthetics, which are part of the economy of growth and overconsumption that drives climate change. I discussed five challenges to dominant definitions of technology, discussed through four submissions to the SFPF, as well as Steyerl's poor image and Cubitt's eco-political aesthetics. (1) Small file aesthetics are low resolution by choice in a resistance against the promise of digital technology to render infinite growth sustainable. These images do not anticipate changing the world, as Brand thought NASA's image would, they try hard not to change it too much for the worse by being small. (2) Small file aesthetics take a situated, embodied and partial perspective, accountable towards the world depicted. Small images express an awareness of their materiality and of the interrelations between the position of the photographer, the digital artefact and the world depicted. (3) Small file aesthetics are committed to connecting dispersed audiences, not unlike the poor image and Vertov's visual bond. It takes a decolonial stance in its resistance against bandwidth imperialism and aims to learn from less wired areas in the world. (4) Small file aesthetics yearn for other worlds through a collective fabrication of alternatives. (5) Small file aesthetics, in line with a situated approach to knowledge production, avoid generalisations and universal solutions. It is not about format wars, aiming at one codec to rule them all, but about inventive use of compression alongside curbing demand and supply and other methods.

Small file aesthetics are an aesthetic of resistance and invention. The festival aimed at reimag(in)ing lowering the networked image's impact beyond increasing efficiency through hardware, compression standards and software. These efficiencies, as shown in Cubitt's discussion of Green MPEG and Sneyers' experiences with JPEG XL, are usually led by engineers at the service of industry, with very different goals in mind, such as avoiding problems of network congestion and lag at the receivers end while transferring high definition imagery, ensuring so-called Quality of Experience (QoE). The environmental impact of such measures is not a concern and the push for ever higher resolutions is motivated by the tech industry's need for rapid obsolescence of devices to keep sales up, leading to a whole set of indirect environmental impacts through the need to upgrade screens, devices and network infrastructure to be able to transmit and display this high resolution material.

In many ways, efficiency at the service of QoE resembles most corporations' sustainability plans, such as Google's, in which there is a lot of emphasis on efficiency in the form of Power Usage Effectiveness (PUE) of their data centres, only demonstrating a relative lowering of electricity use, not an absolute one. While only taking into account their own data centres for the calculation of their CO_2 emissions, Google disregards the data centres it rents and the emissions caused by its products downstream. Next to that, PUE neatly distracts the public from talking about the environmental impact of their core business models: targeted advertisement with the goal of selling more goods and services, providing services based on AI, which is problematic for many reasons, including its enormous environmental footprint (Kirkpatrick, 2023). The oil industry is a more extreme but clearer example, talking about energy efficiencies with terms such as clean energy and net zero while investing next to nothing in renewable energy, expanding their oil production and not counting the emissions caused by the burning of their product. Efficiency is the spell that removes choices about possible alternatives from the realm of political decision making processes.

This chapter demonstrates that efficiency at the service of QoE does not make sense. Next to the rebound effect (meaning overall consumption will increase as efficiency rises) QoE does not depend on high resolution in the first place, it depends on the quality of the material beyond the amount of pixels per inch; its capacity to communicate with people in less wired places, with people using older hardware, to captivate, to enchant, to slow down and spend some time with an image, to listen to its story. Real gains are to be had by opening up degrowth in the arena of online visual culture, by delinking QoE from always faster bitrates and higher resolutions so that we can keep our old screens and cameras and phones and networks, so we don't need more and bigger data centres. Not every image or video needs to be heavily compressed or tiny, there is room for diversity, a time and place for every type of digital image. Ansel Adams desired perfection in prints because his work required it, but his work also didn't have to travel over networks at the speed of light, it was exhibited and 'consumed' at a very slow pace.

Small file photography is another genre altogether, one that doesn't perform environmentalism through enchanting people with the beauty of nature but by embodying its own materiality and in solidarity with other networks than fiber optic ones. Marks and Przedpełski (2021) describe small file media as anti-bandwidth imperialism and discuss how in Lebanon Internet speeds are slow and that apart from a small urban elite, nobody has access to high bandwidth and makes do with slower speeds, lower resolutions. The small image is aligned with their proposition to take so-called data poor countries as a model, rather than aiming at high bandwidth for the entire planet, based on the idea of unlimited capacity of infrastructure as well as unlimited carrying capacity of the Earth.

They acknowledge that it might not be fair to ask these countries to teach the Global North more sustainable ways once more, but argue that it is urgently needed (Marks and Przedpełski, 2021). The small image is poor, anti-capitalist and anti-bandwidth imperialist because it can be captured using old phones and cameras, it can circulate on old networks and computers, can be displayed on old screens, stored on tiny storage media and is accessible and (re)producible in places with low bandwidth. Its situated perspective is in direct opposition to the distant one of seeing Earth from space, something akin to what Haraway has called the 'god trick': seeing everything from nowhere, an unaccountable and disembodied perspective, distancing the knowing subject "from everybody and everything in the interests of unfettered power." (Haraway, 1988, p. 581) The small image connects bodies with objects in networks of relations, taking a situated perspective and a political one, aware of power relations embedded in material technical praxis, a redefinition of tech through a strong political, environmental, decolonial stance (visual bond) that, in combination with strategic politics, challenges capitalist sorcery's most powerful spells.

The Art of Creating Suspense

> “This is what my thought experiment was trying to explore: the possibility that dynamic collectives of knowledge-construction might come together in an apprenticeship to this art of creating ‘suspense’.” (Stengers, 2017, p. 72)

Summary of the argument

This dissertation started by outlining a problem: (inter)governmental efforts to deal with the climate crisis are all based on a definition of technology that makes the consolidation of two incompatible aims—economic growth *and* environmental sustainability—seem possible. This specific definition of the word is invested with a strong and well financed drive to keep existing power structures in place. However, the paradox at its heart does not go unnoticed, which leads to my central thesis: the definition of the word technology in the climate crisis is becoming brittle; the mismatch with lived experience and material practices becomes increasingly stark; this gives rise to many new terms associated with communities of practice which give voice and shape to different definitions of, and roles for, technology on a damaged Earth.

I approached the argument through two angles: direct and indirect, materially and on the level of discourse. I directly and materially engaged with redefinitions by looking into how communities practically experiment to lower the impact of ICT, avoiding the blind spot within sustainability studies, where ICT is often still thought of as solution to, rather than cause of, environmental problems (Kuntsman and Rattle, 2019). At the level of discourse, I looked into how small communities give expression to a changing perspective on the role of technology in the climate crisis. The main research question I posed is: how have several new terms for environmentally less damaging ICT, and their related practices, given expression to redefinitions of technology in relation to an escalating environmental crisis? To answer this, I explored the historical terms soft technology and Appropriate Technology, the contemporary term permacomputing, six terms associated with feminist server practices, and photographic practices giving a visual redefinition of technology. The objective of this inquiry was to demonstrate that this wealth of new terms is a symptom of technology's definition becoming brittle, creating space for alternative interpretations, with the motivation to foster their transformative potential.

The shifts, over time, in the meaning of such a pivotal word as technology are an important object of study because these reflect political shifts and are symptoms of underlying social contradictions. They say something about how 'consensus reality' emerged and where it starts to break down. These insights help imagine how change might be brought about (Fritsch, O'Connor and Thompson, 2016). In this dissertation, I describe practices that are experimenting with different definitions by quite literally seizing control over the means of communication as the means of production, because not only do they take control over the elements of network technology within their reach, some of the communities of practice involved also actively shape the vocabulary used to discuss this. This dissertation aims to bring understanding of how the language around these infrastructures expresses this change, bringing the means of production in line with the interests of practitioners. Each practice, when situated historically, can teach us something about their transformative character and potential, a low theory about questions emerging from these projects, fostering experimental togetherness, a pragmatic learning of what works and how (Graeber, 2004; Stengers, 2005). Exploring the contested meaning of technology, a word holding such a pivotal position in debates about ways to tackle climate change, can provide important insight into how this position emerged and support imagining how to change Brand's (1968, p. 1) *Whole Earth Catalog* statement, "[w]e are as gods and might as well get good at it" into this dissertation's own battle cry: we are as humans and might as well get used to it.

Before exploring the diversity of terms themselves, I established why these new terms came about in the first place. In chapter 1 I explored the role of technology in the environmental crisis historically, the response of the tech industry to criticism of its own environmental footprint and the heavily burdened position individuals and communities find themselves in when trying to respond. The increasingly powerful position of technology within international discourse on how to tackle the climate crisis was accomplished by 'the pivot', a sharp twist in the framing of growth as the source of environmental decline to growth as solution, a narrative about the 'dematerialisation' of industrial production made possible by technology. Suddenly, poverty was said to be the great polluter rather than the highly industrialised nations of the Global North. Despite the normalisation of this twisted narrative, the tech industry faced growing criticism about the environmental damage caused by its operations, to which it responded by outsourcing responsibility for damage to others, effectively individualising the problem of ICT's environmental impact. If we would all simply watch less cat videos, and stop binge watching *Game of Thrones*... These two twists made the term technology uninhabitable for activists, developers and artists working on diminishing the environmental impact of their ICT.

I also needed to establish the relevance of the small scale practices associated with these new terms, as they might seem futile in the face of an industry which conquered such a pivotal role in the discourse about the fight against environmental collapse. This role placed Big Tech in an increasingly powerful position. Not only is it providing the 'alibi' to the industries and economies of the Global North for continuing business as usual, it also made these economies dependent on its services. More and more people rely on Big Tech's products world-wide. This constitutes a double capture, in the form of vendor lock-in and one of the imagination, naturalising class interests. How to resist? The pragmatic Marxism of Stengers and Pignarre helped build the case for challenging capture through pragmatically and experimentally performing other worlds. Their approach to resistance as a type of magic, denaturalising narratives that lead to this double capture, helped break the spell of scale that leads to the immediate dismissal of anything other than total system overthrow. The anarchist anthropology of Graeber complimented this by arguing for the value of engaging with communities that create viable alternatives and consider the larger consequences of their practice (Graeber, 2004). Both Stengers and Graeber argue for the necessity to offer those ideas back to those it concerns, "creating relations and knowledges worth cultivating." (Stengers, 2017, p. 82) These ideas support the relevance of the study of this proliferation of new terms, and their related practices, redefining technology in the climate crisis.

The dissertation begins in the decade when *Limits to Growth* and other publications generated public pressure on governments in the Global North to degrow their economies: liberatory technology, tools for conviviality, soft technology, Appropriate Technology, biotechnic and Alternative Technology. Three decades later feminist technology, low-tech and redundant technology appeared, and another three decades after that: retrocomputing, small tech, sustainable computing, minimal computing, solar punk, permacomputing, benign computing, computing within limits, slow tech, collapse informatics, convivial computing, salvage computing and more followed (de Valk, 2021a). Some of these found their way into this dissertation, others became an entry in the *Damaged Earth Catalog*.

When looking back to the late 60s to late 70s, the decade when two conflicting worldviews collided: one based on unlimited and the other on limited natural resources, I explored two approaches which at first glance seemed similar: soft technology and Appropriate Technology. After closer inspection, soft technology turned out to be a reverse engineered distancing from Appropriate Technology, which had evolved from an anticolonial effort to bring local economic autonomy to rural India, into colonialism by other means, through the deployment of technologies which avoided investment in rural areas in the Global South. Soft technology brought countercultural cachet to the tech industry, but didn't challenge the mainstream view of technology as an enabler of economic growth without environmental damage. Instead it re-enforced this idea by pushing the concept of ephemeralisation—doing more with less. It promoted a technology-enabled lifestyle activism, a precursor to the combo of green consumerism and ecomodernism, a tech-utopianism which in effect became the mainstream definition of technology. In contrast, practices that came out of Appropriate Technology, such as Alternative Technology and biotechnic in the UK, 'looked alike' but posed real challenges to the hegemonic definition of technology through their commitment to communitarian anarchism, degrowth and citizen science. However, it lacked a philosophy of change beyond modelling change, which rendered it powerless when it was abandoned at the level of government when the oil crisis came to an end. Tech as solution to environmental collapse became the dominant ideology, fuelling the myth of 'green growth'.

My involvement with the permacomputing community led me to an in depth discussion of some of its main characteristics. By looking into inherited elements from past practices, I realised its strange legacy: a view on technology inspired by a form of agriculture which was inspired by a view on technology. This legacy from permaculture, soft technology and Appropriate Technology brought it its abstract design principles and its current lack of strategic politics connecting its small scale interventions with transformative projects on a larger scale. This inheritance stands in the way of accessibility and larger scale transformative impact. Permacomputing does however propose strong redefinitions of technology through its reversal of the pivot performed by soft technology. It reasserts technology as part of the problem, a rematerialisation rather than ephemeralisation. The practices of observation and 'not doing' create space for a commitment to skill sharing, access and inclusivity and attention to decision making processes as opposed to 'fixing' a technology through increased efficiency. It challenges the dominant definition of technology by breaking the sorting spell that dismisses existing and past practices as regressive, a denormalisation of the wasteful and toxic Silicon Valley rhetoric of progress and innovation.

My experiences and observations while travelling with the six communities gathered around (eco)feminist server rosa through Europe in 2022 resulted in a chapter that pushed back at the male dominated space of tech and, for lack of new vocabulary, coined 6 new words to hold space for important and relevant practices that are often so everyday and low key, nobody thought to name them. When asking each participating organisation about how they envision the relation between the way they approach their ICT and its environmental impact, each had a different response that reimagined and redefined technology. These practices broaden what technology means, taking it from the narrow masculine world of high-tech and bringing it into the domain of gender minorities, BIPOC, women and disabled people. These practices face the question of why certain technologies became dominant head on, knowing from experience how certain inequalities are reproduced through computing practices. Their strong focus on social and community needs over tools, the linking of strategic politics with prefigurative politics (informed by knowledge about how inequality is reproduced at different scales) leads to the everyday practice of resisting Big Tech. This often translates to environmentally more sound practices, even when they aren't articulated as such. Attempts to reduce the damaging effects of tech could learn a lot from these practices and the struggles they experience, from their research and writing.

I concluded this inquiry into the contested meaning of technology, by returning to the start of this story, to the image that would change the world, and looked at photographic practices engaging with the environmental impact of digital photography. The Small File Photo Festival was an intervention aimed at challenging capitalist sorcery's most powerful spells, scale and efficiency, through the lens of the small image, a visual redefinition of technology. The small image, like many of the practices I discussed earlier, almost automatically conjures up the magic word scale which would lead to its dismissal, but by looking into how the small image confronts the climate crisis it turns out that the positioning of the individual and small act against the systemic problem is a dishonest representation of the choices faced by activists and artists alike. Problems are reproduced at different and interrelated scales. The small image also summons the magic word efficiency, which when interrogated at the level of ICT hardware, software and digital image compression, turns out to be remarkably inefficient at diminishing ICT's resource use. The reflection on four works featured during the festival led to a visual redefinition of tech with a strong political, environmental, decolonial perspective which, in combination with strategic politics, is the much needed pragmatic and experimental performing of other worlds that demonstrates computing otherwise is possible and doesn't only consist of dreams, but also tests ideas in code, hardware and community organisation.

The contested meaning of technology

During the late 60s two opposing and conflicting world-views collided, one based on limited and the other on unlimited natural resources, one arguing for degrowth, the other for growth. The image Brand chose as emblem of his tool-enabled movement expresses the world-view that bets on human ingenuity applied to create what Le Guin called the "linear, progressive, Time's-(killing)-arrow mode of the Techno-Heroic", a definition of technology that would allow for growth without damage (Le Guin, 2019, p. 36). It expresses a way of seeing in a disembodied, distant and universalising way, the whole Earth as experiment. This way of seeing has paved the way for ecomodernism, for genetic modification of crops, the ramping up of nuclear energy production and geo-engineering, as techno-fixes to environmental collapse, allowing for business as usual to continue, keeping existing power structures intact, while putting life as we currently know it at risk and burdening future generations with a toxic and life-threatening legacy. This perspective claims we are as gods, but forgets to mention who 'we' are, which is significant when deciding the fate of Earth's climate. So far, the definition of technology and Big Tech itself have been shaped by the financial elites of the Global North with the purpose of entrenching their interests, geoengineering might very well follow this path. It is therefore urgent to change perspective.

To foster this change, I chose to think with K. Le Guin's redefinition of technology as cultural carrier bag, rather than weapon of domination. I decided on gathering a plurality rather than selecting one 'best practice'. I collected, gathered and brought into relation a diversity of perspectives, thinking about and with practices that, rather than forcing energy outwards, bring energy home (Le Guin, 2019). I connected this gathering of practices with Stengers' call for slow science, finding relevant ways to think together and putting trust in "the plurality of reclaiming operations and the ways in which they may connect, weaving relations with and learning from each other." (Stengers, 2017, p. 141). This thesis forms a low theory of alternative definitions of technology, an open pedagogy concerned with the immediate questions transformative projects deal with in everyday practice, a theory orienting toward problem-solving knowledge and social visions of radical justice (Graeber, 2004; Stengers, 2005; Halberstam, 2011).

The practices redefining technology are all different and evolving, and I want to share some of their characteristics that stood out to me, as I encountered them during this study.

- They are practices with a preference for low tech or no tech as resistance against the false promise of digital technology to render infinite growth sustainable. Technology is seen as part of the problem. These practices do not anticipate changing the world by themselves, by leading through example and without politics, as Brand thought soft technology would. They try hard not to change it too much for the worse by using less resources and producing less waste, and see tools as political yet not as a replacement for politics.

- These practices take a situated, embodied and partial perspective, accountable towards the human and non-human world. These practices express an awareness of their materiality and of the interrelations between the position of the practitioner, the tool and the world.
- These practices are committed to connecting dispersed audiences, not unlike the poor image and Vertov's visual bond. They take a decolonial stance in their resistance against bandwidth imperialism and aim to learn from less wired areas in the world.
- These practices yearn for other worlds through a collective fabrication of alternatives. They turn to solidarity to counter the isolation of the individual as consumer without political power.[31]
- These practices, in line with a situated approach to knowledge production, avoid generalisations and universal solutions. It is not about code or hardware wars, aiming at one computer or programming language to rule them all, but about inventive use of these, only if required, alongside more important methods such as 'not doing', observing, social organisation and political activism.

And therefore...

I am not concluding. This dissertation ends with a successfully established relation without knowing what that may lead to, with suspense. The practices I describe are part of a larger movement of people reshaping technology to meet a community's needs, redefining it in relation to the climate crisis. Future research could support further strengthening and fostering of the relations between this diversity of practices, looking into how these different redefinitions continue to develop, how the communities of practice shape them further and if and which types of alliances are made.

Small scale practices might not make a big dent in global CO_2 emissions, but as discussed in the chapters, problems are reproduced at different and interrelated scales, making it essential to evaluate impact in a relational way. Prefigurative alongside strategic politics, are the much needed pragmatic and experimental performing of other worlds that demonstrate computing otherwise is possible. Rethinking the role of technology in the climate crisis means reconsidering what it is needed for in the first place. Small scale practices are not there to replace Big Tech with small tech, which again, would be an oversimplification and a dishonest way to think about the choices faced by practitioners and activists. There is something more fundamental at stake, a change in perspective that leads to different questions, such as whether hyperscale data centres and the AI enhanced services these enable are needed at all, for which purpose, to serve who's interest, at what cost and over whose (human and non-human) back? These practices have something more nuanced and ultimately more effective to offer than the depoliticising techno-fixes of efficiency and scale: they demonstrate in practice that alternatives are possible and already exist, that many small scale alternatives together create a powerful counter-narrative that can then bring about the change in perspective needed to generate public pressure demanding system change, in solidarity and alliance with others.

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[31] Although not discussed within this dissertation, the concept of digital discomfort, an energising solidarity found in the shared discomfort of life infiltrated by techno-capitalist global digitisation, as developed by and discussed in the work of the *Cell for Digital Discomfort* (CfDD)—composed of Cristina Cochior, Karl Moubarak, and Jara Rocha, is a great inspiration (Cochior, Moubarak and Rocha, 2022).

Portfolio

Introduction to the portfolio

This portfolio contains a selection of publications that were the outcome of the experimental publishing practice by which this study has been informed. As explained in the introduction, this is a practice-led research project, meaning the research uses artistic practice as a means of exploring research questions with the aim to develop new insights and understandings through this process. Informed by the work of Stengers, Graeber and Adema, the practice I used as means of exploring my research question was that of writing and publishing throughout the project, to establish a conversation with those concerned by the research. Publishing is not unidirectional, it's a conversation allowing for questions to be formulated that matter to the researcher but first and foremost to those concerned, who have a stake in the research(ed).

I chose to support this reciprocal relation with the communities of practice I worked with, by making interim outcomes of the project public. I appended this portfolio to the dissertation to give an impression of this practice, to give a more complete picture of the entire project, not just the singular, static and academic outcome. I included a selection of entries from the *Damaged Earth Catalog* wiki and three publications: the lecture-performance *Capitalist Magic*, the lecture-performance *A Tale of Two Data Centres* and the tarot deck *Tangible Cloud Oracle*. An overview of all publications, workshops and talks done throughout the project can be found in the appendix. I'll introduce each publication briefly, to give an idea of the particular context in which it was published and how it relates to the dissertation.

The Damaged Earth Catalog

The *Damaged Earth Catalog* is a wiki; a living document, lightweight and evolving. The Catalog features a growing collection of terms associated with environmentally less damaging ICT and links each to an entry describing its related practice. This 'carrier bag' brings different communities of practice, from academic to grassroots, historical to contemporary, into relation and creates visibility of all these to each other with the aim of supporting strategic synergies and alliances that actually allow honouring differences while still collectively providing a larger scale resistance against the damaging practices (both socially as well as environmentally) of the tech industry. Instead of the consumer activist approach of shopping for the right tools to bring about change, as proposed by the *Whole Earth Catalog*, its evil twin, the *Damaged Earth Catalog*, shares a diverse range of situated practices that reimagine the roles technologies could play on a depleted planet.

I have added (and will continue to add) new entries to the wiki throughout the research project and shared them via the Fediverse and through my talks and workshops around the *Damaged Earth Catalog*. It has been a tool to discuss my research with others and to develop new entries in collaboration, such as *Disability Driven Development* together with Amelia Laumann (2024). It has been the public facing side of this project, gathering a collection of keywords of which some became part of this dissertation while others provided synergies and resonances strengthening the counter-narrative under construction. In line with its content, the wiki's implementation is minimal and lightweight. I have included Liberatory Technology, Convivial Technology, Redundant Technology and Salvage Computing. For more entries, please visit the wiki.[32]

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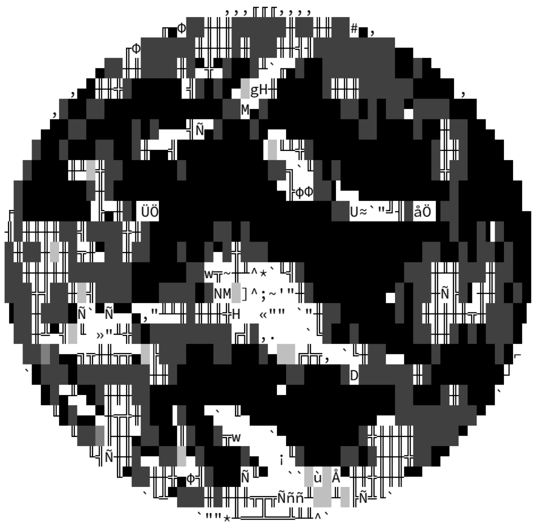
[32] https://damaged.bleu255.com

Damaged Earth Catalog



Purpose

We are humans and might as well get used to it. So far, remotely done power and glory—as via government, big business, formal education, church—has succeeded to the point where gross profits obscure actual loss. In response to this dilemma and to these losses a realm of intimate, community power is developing—power of communities to conduct their own education, find their own inspiration, shape their own environment, and share their knowledge with others. Practices that aid this process are sought and promoted by the DAMAGED EARTH CATALOG. [33]

Function

The DAMAGED EARTH CATALOG functions as an evaluation and access device. With it, the visitor can discover what they might want to learn more about and where and how to do this learning.

An item is listed in the CATALOG if it is deemed:

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[33] Brand's (1968, p. 1) introduction reads: "We are as *gods* and might as well get *good at* it. So far, remotely done power and glory—as via government, big business, formal education, church—has succeeded to the point where gross *defects* obscure actual *gains*. In response to this dilemma and to these *gains* a realm of intimate, *personal* power is developing—power of *the individual* to conduct *his* own education, find *his* own inspiration, shape *his* own environment, and share *his adventure* with *whoever is interested*. *Tools* that aid this process are sought and promoted by the *WHOLE* EARTH CATALOG" (emphasis added).

1. Useful as a practice,
2. Relevant to collective learning,
3. High quality and low cost,
4. Forgotten or new community knowledge,
5. Easily available by mail.

This information is continually revised according to the experience and suggestions of CATALOG readers and writers. [34]

Liberatory Technology

Liberatory technology was described by political philosopher and social theorist Murray Bookchin (1986) in his 1965 essay *Towards a Liberatory Technology.* Bookchin (1986, p. 135) described the possibility of an environmentally-friendly technology, which would “make man’s dependence upon the natural world a visible and living part of his culture”. Bookchin envisaged small communities integrated into the natural environment, using small-scale technologies permitting a decentralisation of population as well as the production of goods; a reintegration of settlements, agriculture and small scale industry. These settlements would have local autonomy as well as a confederation for exchange and organisation across larger areas. Bookchin didn’t see himself as techno-pessimist nor techno-utopian. In his view, technology has no agency of its own. Instead he situated it in, and envisioned it as result of, social organisation. He aimed for a balanced use of technology, exploring its potential as basic structural support of society when it’s not used as a means for value extraction and control over labor. Bookchin’s vision of technology is one that humanises society by liberating people from toil and need.

His vision of a utopian ecological lifestyle inspired many in the UK’s *Alternative Technology* movement, with its related magazine *Undercurrents.*[35] The main characteristic of liberatory technology, in line with Bookchin's anarchist politics, is decentralisation in order to avoid centralised economic and administrative control. Mass communication and miniaturisation of technology and computing would support this decentralised industry and population. It is powered by renewable energy, non-coercive, adapted to specific local needs, small scale and shared among communities. He imagined tools to perform simple and basic tasks, making them multi-purpose, so that they could be used in many different situations, in order to avoid wasting machines once the products they produce are no longer needed. In *Ecology and Revolutionary Thought*, Bookchin (1986) points to the value of organic differentiation, not mechanical standardisation, for balance in society and nature alike. His view of technology reflects this, and resonates with current philosophies on sustainable design, such as that of Arturo Escobar as expressed in *Designs for the Pluriverse*, and resonates with the characteristics of Benign Computing and Permacomputing (Escobar, 2018).

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[34] Brand’s (1968, p. 1) text reads: “The *WHOLE* EARTH CATALOG functions as an evaluation and access device. With it, the *user should know better what is worth getting and where and how to do the getting.* An item is listed in the CATALOG if it is deemed: 1. Useful as a *tool*, 2. Relevant to *independent education*, 3. High quality *or* low cost, 4. *Not already common* knowledge, 5. Easily available by mail. This information is continually revised according to the experience and suggestions of CATALOG *users and staff*” (emphasis added).

[35] *Undercurrents* was a magazine about radical science and alternative technology, which was published between 1972 and 1984. Alternative technology refers to technologies that use renewable energy, are environmentally friendly and low cost. *Undercurrents* magazine featured articles on wind turbines, grey water reuse, composting, anaerobic digestion and more.

What sets Liberatory Technology apart from soft technology and Appropriate Technology is the way it envisions technology as inseparable from a way of social organisation.[36] Technology serves the anarchist, communalist social structure and is shaped by it. Bookchin's ideas could be considered techno-utopian, imagining technology supporting a post-scarcity society, 'solving' the problem of distribution of scarce resources and labour in society, but his strong emphasis on social organisation over technology makes this an unfair comparison.[37] His writing echoes anarchist and geographer Peter Kropotkin's 1899 *Fields, Factories and Workshops*, which deals with the potentials of a combination of decentralised small industries with agriculture, which is "carried on for satisfying real needs rather than for satisfying shareholders by high profits or for pouring gold into the pockets of promoters and bogus directors." (Kropotkin, 1912, p. 118) Kropotkin wrote this in a time when small and decentralised industries were quickly disappearing, after the first industrial revolution, in favour of centralised and large scale factories with increasingly minute division of labour. He emphasised how progress in science and technology allows people to sustain themselves with much smaller amounts of work than as wage labourers and under much better conditions, as long as capitalists, landlords and middle men seeking to extract profits stay out of the process.

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[36] Bookchin was the founder of social ecology, an interdisciplinary field drawing on philosophy, political and social theory, anthropology, history, economics, the natural sciences, and feminism. It recognises that nearly all environmental problems are caused by deeply entrenched social problems such as economic growth, gender oppressions, and ethnic domination. In 1974, Bookchin and Dan Chodorkoff founded the *Institute for Social Ecology*, offering experiential radical education for grassroots organising and community-building.

[37] Bookchin's ideas on technology allowing for a post-scarcity world to come about are clear echoes of Kropotkin's writing. It is important to note that his ideas revolved around the labour saving potentials of technology, not on the problem of resource and energy use. Even though there are worlds to win, also in terms of environmental impact, by reimagining technology at the service of people rather than profit, technological development cannot decouple resource and energy use from economic growth (Lange, Pohl and Santarius, 2020; Freitag *et al.*, 2021). Even though Bookchin wasn't aiming for growth, his post-scarcity utopia conceived of in the 1960s didn't account for the complex and globalised supply chains of current day computing technology, nor for the labour conditions, resource use and pollution involved in its fabrication and disposal.

Bookchin copied this emphasis on the labour-saving qualities of technology. To him, self-regulating control mechanisms in industrial operations and the digital computer are capable of taking over all the physically hard and boring mental tasks of man "in industry, science, engineering, information retrieval and transportation." (Bookchin, 1986, p. 123) His flavour of tech-utopianism goes in the opposite direction of ecomodernism. Instead of using technology to separate man from nature, he believed technology can be used ecologically to reawaken man's sense of dependence upon the environment. To remove the contradiction between town and country, he wondered how land and community could be reintegrated without imposing the painful toil of manual agriculture on communities. He envisioned mechanised, yet small scale agriculture which supports regional ecology.

He pointed to village industries from the past, making use of local energy sources, materials and resources. Renewable energy such as solar, hydro and wind could reduce reliance on fossil fuels. He realised none of these renewable sources can provide for centralised industries and concentrated populations, but saw this as an opportunity to rescale and rethink tempo and size based on these limitations (Bookchin, 1986, p. 152). It would lead to durable goods, conservation of raw materials and technology could reduce toil so that people can dedicate themselves to organisation, crafts and more. He wholeheartedly agreed with the Dadaist call for unemployment for all.

> "The most critical function of modern technology must be to keep the doors of the revolution open forever!" (Bookchin, 1986, p. 153)

Bookchin confronted the lifestyle activism promoted by the *Whole Earth Catalog* in no uncertain terms:

> “We must earnestly deal with the fact that economic growth, gender oppressions, and ethnic domination—not to speak of corporate, state, and bureaucratic interests—are much more capable of shaping the future of the natural world than are privatistic forms of spiritual self-regeneration. These forms of domination must be confronted by collective action and major social movements that challenge the social sources of the ecological crisis, not simply by personalistic forms of consumption and investment that often go under the rubric of ‘green capitalism’.” (Bookchin, 1993, p. 356)

He critiqued practices that didn’t involve counter-systemic social activism, as well as theory and critique without a coherent and practical way forward. Both are needed. He argued for a convergence of strategic and prefigurative activism as a first step toward a political movement that is able to contest and reclaim political power.

The biggest shortcoming of his vision is that it remains unclear how to exactly work towards this utopia. His writing is too general and the bridge from globalised, neoliberal, capitalist industrialism to decentralised, ecological communalism is suggested, yet not constructed. But this is perhaps also exactly the point: imagining a path out requires utopic dreams, the road is made by walking (Horton *et al.*, 1990). Bookchin strongly argued against futurism, which simply extends the present into the future. What he deemed necessary is to change the present so the future looks radically different. He explained his commitment to utopic vision in a 1978 lecture: “if you don’t do the impossible, we’re going to wind up with the unthinkable—and that will be the destruction of the planet itself.” (Huther, 2019)

Convivial Technology

In 1973, Ivan Illich published *Tools for Conviviality* (1973), a book about man's relation to tools. Illich pleads for a pluralism of responsibly limited tools that guarantee an individual's right to work with independent efficiency, the development of which is "as unpredictable, creative and lively as the people who use them" (Illich, 1973, p. 48).[38] He points to overgrowth and overproduction threatening the right to a liveable environment, which unfortunately led him to ideas on gender and population control that are highly problematic.[39] His ideas are included in the Catalog because of their influence on other practices, that picked up on his ideas about limited tools and somehow turned a blind eye to the racist and sexist parts of his writing.

What did inspire others in his work is his imagining of a future society both very modern yet not dominated by industry, which recognises natural scales and limits.[40] Illich's ideas had a big impact on the counterculture. His thinking about social organisation and local interdependence influenced the founders of the permaculture movement, which in turn influenced permacomputing. His ideas about tools created by and for a community of users was a great influence on Lee Felsenstein, one of the first developers of the personal computer, designer of the Osborne-1 and member of the Homebrew Computer Club.

Illich's focus on tools as drivers of change in society, rather than decision making processes under the influence of power structures is very similar to the *Whole Earth Cata-*

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[38] Illich chose the word convivial despite warnings from friends about potential misunderstandings. He explains convivial as a technical term meaning a modern society of responsibly limited tools. He wants it to reflect a disciplined and creative playfulness, disciplined because this playfulness is made possible through austerity, which excludes things distracting from or destructive of personal relatedness. He builds upon the Spanish 'convivencialidad', which stems from the verb 'convivir' (to live with). It means the opposite of industrial productivity, it is "individual freedom realized in personal interdependence and, as such, an intrinsic ethical value." (Illich, 1973, p. 12).

[39] He also points to overpopulation and expresses some extremely conservative, sexist and racist ideas related to population control. Anti-conception is described as essential to curb population growth, but it must be achieved through individual choice, which he sees as incompatible with specialised birth control programs, which according to Illich (1973, p. 43) would lead to mega-deaths through forced sterilisation and abortion. He also posits that improved healthcare in developing countries, leading to more women surviving pregnancies and more children surviving into adulthood, is damaging to these countries which he claims aren't able to sustain a larger population (Illich, 1973, p. 8). His views on gender roles and gendered tools wouldn't look out of place on a tradwife's Insta feed (1982, p. 67). His views on modern healthcare would do well with anti-vaxers (or eugenicists for that matter) (Illich, 1973, p. 10).

[40] A natural scale, to Illich, is a scale at which a tool performs the ends for which it was originally designed. Beyond this scale, its performance deteriorates to the point where it becomes a threat to society itself. What is considered natural by Illich, in the light of his other writings, is problematic but as Theodore Roszak hinted at in *The Cult of Information*, it is unclear if those using the term 'convivial' in relation to technology actually read and studied Illich's theories (Illich, 1973, p. 5; Roszak, 1986, p. 142).

log's emphasis on access to tools.[41] This focus leads Illich to look at limiting tools in a very limited way, setting limits to growth of production, not questioning why this overproduction happens and by which mechanisms it is made possible. Overproduction in consumer capitalism is made possible and profitable because of exploitation of labour and natural resources, yet Illich doesn't discuss how different social organisation could lead to shifts in power. He dismisses (marginalised) worker ownership over industrial corporations as non-transformative, because it wouldn't challenge the mode of production. Instead he criticises the efficiency of tools as the cause for resource depletion and argues for labour intensive tools instead. Here Illich is fighting symptoms rather than the cause and however close he might sound to degrowth economics, his reluctance to think through larger scale socio-political processes makes him sit closer to the individualist and consumerist lifestyle activism promoted by the *Whole Earth Catalog*: groups of people on the frontier of post-industrial society, prefiguring the lifestyle and labour intensive modes of production which according to him, society will be forced to adopt after the catastrophe caused by unlimited growth has taken place (Illich, 1973, p. 65).

> "Continued convivial reconstruction depends on the degree to which society protects the power of individuals and of communities to choose their own styles of life through effective, small–scale renewal" (Illich, 1973, p. 47)

Tools for Conviviality is one of those books that seems to have had an influence larger and wider than its readership, and became a symbol for a smaller scale, humanised technology over which people have control and which supports personal interdependence. Problematic ideas were largely ignored and people instead found inspiration in his reimagining of responsibly limited tools serving the needs of the community in which the tools are operated. This has inspired some to rethink computing. A 1987 paper by A. C. Lemke and G. Fisher describes convivial computing as computing in which the user has control over the tool on multiple levels (Fischer and Lemke, 1987). Convivial computing should give a user a desired amount of control but should not *require* that it be exercised. In their vision, convivial tools will break down the distinction between programming and using programs. They see the distinction between user and programmer as a major obstacle for the usefulness of computers. Convivial tools encourage users to be actively engaged with, and to generate creative extensions to, the artefacts given to them, releasing designers of tools from the impossible task of anticipating all possible uses of a tool and all people's needs. Lemke and Fisher's ideas about what convivial computing could be like are more interesting than their actual steps towards it as described in their writing. Like Illich, they focus on changing the tool, not the context in which it is used, which greatly diminishes transformative potential.

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[41] He blames cars for reshaping cities and making travelling on foot or by bicycle hard. Cars "shape a city into their image", rather than the immense industry lobby resulting in urban planning that made cars almost indispensable (Illich, 1973, p. 35).

Lemke and Fisher describe convivial computing as focusing on 'soft software', that is software that can be changed by the user, simple and modular, in order to avoid having to anticipate what users might want, and ease of use for both casual and expert users. Unfortunately they imagine this can be achieved through intelligent assistants. Microsoft's *Clippy*, an assistant in the shape of a cartoonish paperclip, which was added to Word in 2003 and removed again in 2007, is an example of how assistants tend to increase annoyance rather than accessibility. Lemke and Fisher lack the environmental and social motivations of Illich, yet their modular approach based on the selection and combination of existing software components, and the idea of 'soft software' that turns users into designers, makes convivial computing potentially suitable for use with old hardware and therefore indirectly could encourage repair. Convivial tools are meant to be adaptable to changes in infrastructures, which would be especially true if they were combined with open source licenses which afford adaptation to specific contexts. The combination of some of Lemke and Fischer's ideas about convivial computing with sustainability could give shape to some of Illich's ideas about responsibly limited tools, if those limits concerned both (ethically sourced) resources and (renewable) electricity rather than production or output, and as long as the people impacted by the tools themselves and their production decide on their design and application.

A more recent influence of Illich's *Tools for Conviviality* is Andrea Vetter's *Matrix of Convivial Technology*, a paper proposing a tool for assessing technologies for degrowth (Vetter, 2018). She studied the practices of several grassroots tinkerers, makers, eco-activists and permaculturalists to develop a definition of convivial technologies. She found five dimensions: relatedness, adaptability, accessibility, bio-interaction and appropriateness; and developed a tool relating these to four elements of a tool's life cycle: materials, manufacturing, use and infrastructure. The tool can be used for research, (self)assessment of tools and political education, to make the ethics informing a tool visible. The five dimensions give a sense of what Vetter's take on convivial technology is concerned with.

The first dimension is (1) relatedness refers to how a technology can support relatedness between humans and non-humans. Examples are composting kitchen waste and using it to grow food in a garden, or federated open source software for communication such as email. (2) Accessibility refers to the material and immaterial means to built or use a technology. This relates to both the materials and knowledge needed to construct something, but also the social and financial supports necessary to be able to. (3) Adaptability is about resisting monopolies by aiming for tools that can both link to larger infrastructures but can also function independently. Vetter relates it to the permacultural principle "Use small and slow solutions", which means designing things to work at the smallest scale possible, while remaining practical and energy efficient for that purpose. (4) Bio-interaction refers to going one step further than technologies that are less harmful, it is about actually benefiting ecological cycles, by for instance using materials that are useful in natural systems, while steering clear of green growth in the economic sense. Lastly, (5) appropriateness refers to the relation of input and output in a given context to assess whether a tool 'makes sense' or is wasteful in terms of resource use (Vetter, 2018).

Redundant Technology

Redundant Technology is a term coined by a group of artists who started the *Redundant Technology Initiative* (RTI) in Sheffield, in 1997. The RTI gathered computers destined for the dump and used them in exhibitions. They used a classic guerilla strategy—use weakness as strength. They had no money to engage with technology, so they made that the point of their engagement with technology as if it were by choice. They also applied this positive reinterpretation to environmental and social circumstances. They reinterpreted electronic waste as resource, turning an old computer into aesthetic material, opportunity for learning and if successful, a functional workstation. Likewise, their reinterpretation of unemployment (re)positioned unemployed people as time-rich learners, volunteers, activists and artists (Wallbank, 2024).

This reinterpretation worked as environmental strategy, diverting e-waste destined for landfills, and a social one aiming at spreading computing skills to underprivileged people (Redundant Technology Initiative, 1999). Their formula of exhibiting donated and found technological waste caught them in a virtuous circle. Each exhibition led to more donations which led to more exhibitions, which quickly left them with too many computers to handle. This urged them to start a creative media lab called *Access Space* in 2001; a lab open to anyone to learn, create and communicate online (Redundant Technology Initiative, 1999). Access Space combined recycling old machines with skill sharing, teaching others how to use them so that they ended up actually being used, prefiguring a lot of current practices such as low tech, permacomputing, salvage computing and collapse informatics.

> "Recycle Your Computers with Lowtech!" (Redundant Technology Initiative, 1999)

The RTI proposed creative and playful use of discarded technology to explore what older machines *can* do, rather than focusing on what they can't. They take an explicit anti-art-washing stance through their rejection of art demonstrating the newest and most expensive computers as sales demonstrations. They embraced the limits of old devices and asked:

> "What are computers for anyway? Just to work and buy stuff? Low cost computers can communicate all over the world, we're more interested in expressing ourselves." (Redundant Technology Initiative, 1999)

In 1999 the *Lowtech Manifesto* was written by James Wallbank, initiator of the RTI. The text was based on a talk delivered by Wallbank at *The Next 5 Minutes* conference in Amsterdam that year. He describes Lowtech as technology that is cheap or free, points out that high technology doesn't mean high creativity and states that the restrictions of a medium can sometimes lead to the most creative solutions. It's anti-consumerist, anti-artwashing and promotes accessibility and independence through open formats, open source software and repairability. It promotes the use of plain text and images on the web because it is simple, cheap and quick, prefiguring the small net (Wallbank, 2000).

> "A lot of people say that new media is revolutionary. They say the net is

> anarchic and subversive. But how subversive can you be in an exclusive club, with a $1000 entrance fee?" (Wallbank, 2000)

The ideas of the RTI spread further through their 2005 *Grow Your Own Media Lab* project.[42] They worked with other community organisations across the UK to see if they could adopt some of Access Space's successful tactics, which led to the start of other labs such as the *Mediashed*, initiated in 2006 by Graham Harwood, Matsuko Yokokoji and Richard Wright of artist collective Mongrel, in Southend on Sea.[43] A lot has changed since then. Access to the Internet became more ubiquitous due to the appearance of smart phones and publishing content online became the norm since the advent of Web 2.0 and social media platforms. Yet the practices promoted by *Access Lab* never lost relevance and collectives working to reduce the harmful environmental and social impact of IT today return to many of the ideas shared by the RTI.

Artist Heath Bunting characterised RTI's work as 'NINJA Economics' (Wallbank, 2024). Not only because RTI engaged NINJAs (No Income, No Job or Assets):[44]

> "[W]e also practised a kind of self-taught economic martial art—tumbling backwards in response to attack, gaining the initiative and pulling the attacker (in this case, our economic circumstances) with us." (Wallbank, 2024)

While wealth inequality keeps increasing and the climate crisis is acknowledged yet not addressed by governments, RTI's guerilla tactic of reinterpreting a problem as a strength and resource, in the case of both technology and people, is more relevant than ever.

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[42] The project resulted in a publication, a short zine-like guide to creating your own community media lab using parts found in the garbage. The publication doesn't discuss any technical issues, but focuses on what is important to consider when starting a lab and why it is important to invest time in learning and skill sharing, rather than buying expensive equipment (Wallbank, 2008)

[43] Mediashed was the first free media space in the east of the UK. It was active for 2 years. "Free-media is best thought of as a means of doing art, making things or just saying what you want for little or no financial cost by using the public domain and free software and recycled equipment." (Mediashed, 2008)

[44] Heath Bunting's remark was made at the lecture series *Anti with an E*, which took place in *Backspace*, London, March 1997. The location of the event also housed offices of record label NINJA Tune. Bunting attributes his awareness of the acronym NINJA to this proximity (Wallbank, 2024).

Salvage Computing

Something a lot of the other terms in this Catalog have in common is an emphasis on resource minimalism and repair, yet many communities trying to lower their environmental footprint are currently seeking this minimalism in hardware that is very hard to repair and is newly produced. Salvage computing is a response to this hype of small low-power single-board computers, aware of the resulting production of yet more electronics while the world is swimming in e-waste.[45] Devine Lu Linvega, one of the voices of the solarpunk merveilles.town Mastodon instance, proposes that creating software targeting old hardware might be a better approach (Linvega, 2022). Gemini creator Solderpunk thinks along similar lines when writing: "the real long-term future of computing consists of figuring out how to make the best possible use we can out of the literal millions of devices which already exist" (Solderpunk, 2020). Sociologist Jennifer Gabrys (2012, p. 133) describes salvage as a practice of engaging with the discarded "with an eye to transforming what is exhausted and wasted into renewed resources". She adds the important observation that this process also means engaging with the conditions that led to disrepair.

ICT requires immense amounts of resources and energy: metals, rare earth minerals, water, silicon, and plastics, as well as fossil fuels for their extraction, transport, production, utilisation, and disposal. The use phase of many electronic items represents the smallest part of the total energy consumption across their lifespan. Production and disposal weigh heaviest on the planet. This burden is unequally distributed. While the Global North is the biggest consumer of ICT, the Global South is where most of the mining, production, and disposal of hardware takes place (Abalansa *et al.*, 2021). Salvage computing reduces damage through hardware repair, the development and maintenance of open-source software for older devices,[46] and political action in the form of lobbying policy makers to introduce regulations that enable these practices.[47]

The Right to Repair movement, the Restart project, repair cafes, iFixit and U-Fix-It are all targeted at making devices last longer but with the exception of the Right to Repair movement, do not focus on the conditions that led to disrepair: planned obsolescence, the rapid upgrade-or-die cycle of the tech industry and consumer capitalism in general, not to mention the impact of this on the Global South, which is receiving the Global North's e-waste and suffers from the pollution caused by the production of the Global North's technology. Out of precarity, and because of the ongoing impact of colonialism, there are very rich and creative repair practices in existence—Jugaad, Gambiarra, Resolver, Shanzhai. Because of the sudden attention in the Global North to e-waste and supply chains, these practices of improvisation are appropriated and fetishised, yet as architectural historian Ginger Nolan argues, the romanticising of the inventiveness of these practices can function as an excuse to keep economic instability and precarity in place (Nolan, 2016). Simultaneously, in high income countries repair practices are only accessible to those with sufficient leisure time, access to knowledge, repair tools and workspace or at least to welcoming shared spaces to (learn about) repair together. An intersectional approach acknowledging this problem of unequal access is fundamental to an inclusive and non-dogmatic repair culture. Media theorist and art historian Shannon Mattern (2024) raises the question whether repair is about conserving the status quo or about inciting systemic change. She argues for critical repair, that questions normative uses and the values embedded in those norms and compares the scale on which repair practices operate with that of the climate crisis:

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[45] The term focuses mostly on practices of repair in the Global North, because this is where the overconsumption of electronics takes place and most e-waste is generated, yet repair practices have all but disappeared.

[46] Manufacturers stop software support long before the hardware breaks, rendering a device unusable.

[47] The Right to Repair campaign, for example, fights for regulations to make the production of repairable devices mandatory, while the Restart Project organises, and helps others to run repair events.

> "Maybe 'repair' itself is too modest an intervention for planetary-scale injuries. Maybe what's required is abolition, the building of new, 'life-affirming' alternatives." (Mattern, 2024)

At this moment, computing is so pervasive, the search for new and life-affirming alternatives needs to go hand in hand with reducing the environmental and social harms of mainstream computing. Without romanticising these practices or ignoring the conditions leading to disrepair, making do with existing and already produced technology saves a lot of resources simply because nothing new needs producing and no e-waste needs processing. Keeping up with the latest developments in hardware and software is not affordable for most, globally, and therefore excludes the disadvantaged from participation in using software services and software that requires recently produced hardware.

This exclusion puts the already marginalised at a further socio-economic disadvantage. This is a strong motivation to work on making older hardware functional for longer. Another reason is solidarity with workers in production facilities and formal as well as informal e-waste processing, who are exposed to toxic materials, hazardous working conditions and are poorly remunerated. Next to that, the environmental harm in the form of pollution, water and energy use, further endangers the health and well-being of workers and citizens living in proximity of factories, microchip fabrication plants and mining facilities. Individual abstention doesn't solve systemic problems, necessitating a combination of strategic politics with mutual aid as complementary aspects of this practice.

Salvage computing operates at multiple interconnected scales, from strategic politics to DIY and DIWO. To make repair possible and sustainable, it has a political agenda focused on degrowth and alternative economic models. It supports demands for new laws requiring producers of electronic devices to make their products last longer (planned longevity), to make them repairable, which means: modular design, production of affordable replacement parts,[48] software and firmware updates and the eventual release of those as open source software, allowing others to take over after support is no longer required by law. Salvage computing supports local repair economies, including commercial businesses, grassroots and activist projects, from repair-shops to repair-cafes and hacklabs. This support includes the push for legalising repair activities on proprietary hardware, as well as financial support for community projects. At the level of software development, there is a focus on open source software and operating system development for older devices. Locally as well as online, the construction of a knowledge commons on how to do repair and hands-on skill sharing can help individuals and communities looking to work with existing hardware.

Enabling factors are legislation and regulation requiring manufacturers to make devices repairable, with as a first step advocacy for right-to-repair legislation (Lepawsky, 2020). Part of this should be enforcing the use of universal components, connection standards such as USB and interchangeable parts by manufacturers, to ensure current and future compatibility between devices (Sutherland, 2021). Making restricting end-user license agreements and the criminalisation of third-party repair illegal is an important step (Lepawsky, 2020). If repairing is not an option, reusing a device in a different way than its intended purpose, is another path, requiring a shift in lifestyle choices; from wanting to possess the latest gadget to a situation in which it is desirable to own a device for a long time, which is currently often associated with poverty (Remy and Huang, 2015; Roura *et al.*, 2021). Blevis et al. (2007) call this *New Luxury*, where products are considered luxurious because they are of high quality and standard, not because they are expensive. Heirloom computing is a related term, expressing the desire for long lasting computing hardware that could be passed down from generation to generation (Lord, 2020). On the software-side, enabling factors are creating software targeting old hardware, encouraging developers to test their software on older devices, to push back against software 'progress' deprecating still functioning hardware (Solderpunk, 2020; Linvega, 2022). Roura et al. (2021) point to a need for a different bookkeeping practice, one that does not devalue devices faster than their actual lifespan, creating the idea of valueless items that will trigger institutions and companies to purchase new devices.

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[48] Manufacturers should provide affordable spare parts for a substantial time after the release of a product. The European Parliament adopted the Ecodesign for Sustainable Products Regulation (ESPR) in April 2024, which is meant to improve the repairability of products. The actual requirements for different product groups are being negotiated at the time of writing.

Other enabling factors are skill sharing, documentation of repairs and the sharing of that documentation. This includes the support of social networks and institutions interested in computer repair, invaluable for sourcing parts and maintaining the skills needed for successful repair culture (Jang *et al.*, 2017). An example of an online community documenting repairs to consumer electronics, including computers and smartphones, is iFixit.[49] The Restart Project, a UK based organisation that started in 2013, is organising repair events across the UK and internationally. The project also lobbies for the Right to Repair in the UK and Europe. Lastly, in the Netherlands, many city councils have started repair cafés that welcome citizens to bring their broken devices in for repair in community centers. The Repair Café initiative was started in 2009 by journalist and activist Martine Postma in Amsterdam. Today, there are about 2000 cafés worldwide. Next to these grassroots initiatives, there is also a lively commercial smartphone repair culture consisting of small shops, also extending into hacklabs and fablabs, with an associated ecosystem of sourcing spare parts and skill sharing; unauthorised, sometimes very creative and often illegal interventions (Nova and Bloch, 2020).

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[49] iFixit documents over 80.000 repairs and also sells commonly needed materials, tools and spare parts (iFixit, 2025).

Computer scientists Barath Raghavan and Shaddi Hasan (2016) acknowledge a salvaged Internet cannot be sustained in the long-term. Still, considering today's urgent need to shrink consumption of resources, it is surprising to see that from the list—refuse, reduce, reuse, repair and recycle—the last one is the most wasteful, yet has gotten most attention. This emphasis on recycling can only be explained because the other four point to economic degrowth, an unpopular topic in mainstream politics to date.

Capitalist Magic

Welcome to *Capitalist Magic*, a lecture-performance using montage writing as experimental method to give insight into how new technologies are narrated by those who have a financial stake in their broad adoption (de Valk, 2022).[1] The performance aims to demonstrate the ways narratives about technology, in this case AI, are constructed and spread.[2] The aim of the performance is to de-normalise this narrative by making a clear connection between the narrative and the financial stakes of the people quoted, breaking the spell that strengthens public acceptance of new technologies as fixes to complex social problems such as climate change.

The montage is constructed of publicly available, online material such as recorded talks and interviews. During the performance I read the text without informing the audience that the talk was a montage of quotes. During each quote, a logo of the company the person quoted had a stake in was displayed. The text focusses on the AI spring between 2010 and 2018, paving the way for the currently ongoing AI summer. In 2022 I turned the performance into a paper, with footnotes providing information about the financial stakes of the person quoted, including a link to the source material, situating the montage in relation to the performative utterances it borrows from.[3]

The resulting montage shows the transformation of something hard to accept—the automation of human labour and a growing consumption of scarce resources—into something that could save humanity from the problems it faces. It shows how the future of technology is shaped by an elite and uniform group of people who promote a type of transhumanism that denies human and planetary limits, with devastating environmental effects. It has informed the writing of chapter 1 of the dissertation, especially the choice to focus on discourse analysis around technology and climate change to situate the later chapters in this larger narrative.

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[1] I borrow the term and technique of montage writing from Walter Benjamin's method in *The Arcades Project*, a work of literary montage which composes a narrative using small fragments, both quotes and self-written pieces, which are organised in themes (Benjamin, 1999).

[2] I performed it at V2_ in Rotterdam (2017), 34C3: TUWAT in Leipzig (2017); Varia in Rotterdam (2018); Art Meets Radical Openness in Linz (2018) and *NØ LAB: Post-Despair* in Paris (2022).

[3] It was published as part of the proceedings of NordiCHI 2022 *Participative Computing for Sustainable Futures*, chaired by Ida Larsen-Ledet, Søren Pold and Winnie Soon (de Valk, 2022).

Capitalist Magic

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“During our lifetime we’re about to see the transformation of the human race” “Truly something that blows my mind every time I think about it.” “People have no idea how fast the world is changing… I want to give you a sense of that, because it fills me with awe, and with an extraordinary sense of responsibility.”[4] “We’re the dreamers and the doers, who take risks at amazing new ideas to make them a reality.” “You’ll hear tonight from people who are rewriting the rule book, focusing on what will work best for the future, not just what was done in the past. They’re breaking down intellectual barriers so we can understand societies most profound problems and fix them. [...] They’re using the latest insights on intelligence to debug our most powerful tool for innovation, the human mind [...] They are reinventing government with startup countries to bring the innovation and diversity of the consumer sector to politics. These are big ideas and as innovators, you are the best at finding and nurturing the right big ideas that can change the world.”[5]

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[4] Peter Diamandis, January 2017, in *Imagining the Future: The Transformation of Humanity*. Diamandis is founder and chairman of the X Prize Foundation. The Foundation organises competitions intended to trigger innovations for the benefit of mankind, using crowdsourcing, game-mechanics, and prize-theory. The IBM Watson AI prize started in 2016 and finished in 2021, aimed to accelerate adoption of artificial intelligence. The foundation’s *sponsors* include Google, Shell, IBM, Qualcomm and Tata Group. Trustees and *personal sponsors* are a.o. Elon Musk, Wendy Schmidt, Larry Page and Ray Kurzweil (TEDx Talks, 2017).

[5] Patri Friedman, December 2010, in *Breakthrough Philanthropy Introduction.* Friedman is a self-proclaimed transhumanist and anarcho-capitalist. In 2008 he founded *The Seasteading Institute*, with seed money from Peter Thiel. The Institute’s goal is to establish permanent, autonomous ocean communities with diverse social, political, and legal systems. In 2019 he founded *Pronomos Capital*, also backed by Thiel, a venture capital firm aiming at bankrolling the construction of experimental cities in developing countries, hoping to attract foreign businesses seeking friendlier tax treatment (Thiel Foundation, 2010).

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“My view is there’s no bad time to innovate.”[6] “I think it is a momentous, momentous development that will change our world … and even the course of our species in ways that are hard to predict today.”[7] “We are now more empowered as individuals to take on the grand challenges of this planet, we have the tools with this exponential technology, we have the passion of the DIY innovator, we have the capital of the techno-philanthropist and we have 3 billion new minds coming online to work with us to solve the grand challenges, to do what we must do. We are living into extraordinary decades ahead.”[8] “I want to give you a sense of why now is different, why is this decade, the next decade, not interesting times, the most extraordinary times ever in human history, and they truly are.” “What we’re talking about here is the notion that faster, cheaper computing power, which is almost a force of nature, is driving a whole slew of technologies.” “ […] that is why we’re heading towards this extraordinary age of abundance.” “Imagine 8 billion people on planet earth connected with a megabit per second connection with access to the worlds information on Google.[…] If you thought the rate of change was fast, you haven’t seen anything yet.”[9]

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“We help […] create a world with better technology, less violence, more liberty and longer, healthier more prosperous lives. The future will not take care of itself […]” “As we know the world looks to America for progress, and America looks to California, and if you ask most Californians where they get their progress they’ll point towards the bay, but here at the bay there is no place left to point… so we have to create solutions.”[10] “History has had many moments like today. As we’ve made our great leaps from tribes to cities to nations […]. At each step we learned how to come together to solve our challenges and accomplish greater things than we could alone. We have done it before and we will do it again.”[11] “My goal is to simplify complexity.”[12] “Take internet technology and cross it with an old industry and magic and progress and big things can happen.”[13] “I think it starts with understanding that the world is going to go self-driving and autonomous. Because, well, a million fewer people are going to die a year. […]—quality of life goes way up.” ”I can’t be wrong.”[14]

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[6] Jeff Bezos, April 2008, in an interview with Bloomberg *on innovation.* Bezos is founder and executive chairman of Amazon, a tech company focussing on e-commerce, cloud computing and AI. (Bloomberg, 2008)

[7] George Lee, October 2016, in *Artificial intelligence will change the ‘course of our species’: Top Goldman tech banker*. George Lee is Co-Chief Information Officer and formerly co-chairman of the Global Technology, Media and Telecom Group for the Investment Banking division at Goldman Sachs (Cutmore, 2016).

[8] Peter Diamandis, February 2012, in his TED talk *Abundance is our future.* Diamandis is cofounder and vice chairman of Space Adventures Ltd., a space tourism company, and cofounder of Planetary Resources, a company developing technologies for asteroid mining, with the goal to “expand Earth’s natural resource base.” (TED, 2012)

[9] Peter Diamandis, December 2016, in *Abundance In the Exponential Industrial Era*, a talk during Singularity University’s Exponential Manufacturing Summit, on the emerging technologies shaping the future of manufacturing (Singularity University, 2016).

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“I really think there are two fundamental paths [for humans]: One path is we stay on Earth forever, and some eventual extinction event wipes us out.” “I don’t have a doomsday prophesy.” “But history suggests some doomsday event will happen.” “The alternative is, become a space faring and multi-planetary species.” “It will be like, really fun to go, you’ll have a great time […].”[15] “We will settle Mars. And we should, because it’s cool.” “When it comes to space, I see it as my job to build infrastructure the hard way. I'm using my resources to put in that infrastructure so that the next generation of people can have a dynamic, entrepreneurial solar system as interesting as we see on the Internet today. I want thousands of entrepreneurs to do amazing things in space." "We want the population to keep growing on this planet. We want to keep using more energy per capita."[16]

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[10] Jim O’Neill, December 2010, in the introduction to Thiel Foundation’s *Breakthrough Philanthropy: Giant Leaps for Mankind* evening. O’Neill is founder of the Thiel Foundation, former managing director of Clarium Capital Management, Peter Thiel’s macro hedgefund, managing director at Mithril Capital Management, also launched by Thiel. O’Neill is on the board of the Seasteading Institute (Thiel Foundation, 2010)

[11] Mark Zuckerberg, February 2017, in *Building Global Community*. Zuckerberg is CEO, chairman and controlling shareholder of Meta Platforms (formerly known as Facebook) (Zuckerberg, 2017).

[12] Jack Dorsey, January 2011, in a TechCrunch transcript of an interview of Dorsey by Charlie Rose: *“It’s Really Complex To Make Something Simple”*. Dorsey is the founder and former CEO of Twitter and founder and CEO of Block, Inc., a digital payments company (Schonfeld, 2011).

[13] Travis Kalanick, March 2016, in a *CNBC interview*. Kalanick is co-founder and former CEO of Uber, a ride-sharing, food and package delivery platform. Uber circumvents local regulations and labour rights by claiming it is a tech company, not a taxi company (Cutmore, 2016).

[14] Travis Kalanick, August 2016, in *Travis Kalanick on Uber’s bet on self-driving cars: ‘I can’t be wrong’*. From 2015 until 2021 Uber was developing self-driving cars. In 2016 Uber bought Ottomotto, a self-driving truck company founded by Anthony Levandowski, co-founder of Google’s self-driving car program (Carson, 2016).

[15] Elon Musk, September 2016, in *Elon Musk Announces His Plan to Colonize Mars and Save Humanity*. Musk is founder, CEO and chief engineer at SpaceX, an aerospace manufacturer and communications corporation. SpaceX manufactures rocket engines, launch vehicles, spacecrafts and the Starlink communication satellites, providing internet access to 32 countries. SpaceX has launched 2,091 satellites (February 2022) (Stockton, 2016).

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"Death makes me very angry [...]."[17] "Probably the most extreme form of inequality is between people who are alive and people who are dead."[18] "I think there are probably three main modes of approaching [death] [...]" "You can accept it, you can deny it or you can fight it. I think our society is dominated by people who are into denial or acceptance, and I prefer to fight it."[19] "I have the idea that aging is plastic, that it's encoded [...]" "If something is encoded, you can crack the code." "If you can crack the code, you can hack the code!" "thermodynamically, there should be no reason we can't defer entropy indefinitely. We can end aging forever."[20] "[To] create technologies enabling the transfer of a individual's personality to a more advanced non-biological carrier, and extending life, including to the point of immortality."[21] "This is not about Silicon Valley billionaires living forever off the blood of young people [...]" "It's about a 'Star Trek' future where no one dies of preventable diseases, where life is fair." "Health technology, [...] is becoming an information technology, where we can read and edit our own genomes."[22] "If you ask me today, 'Is it possible to live to be 500?' the answer is yes." "We aren't trying to gain a few yards. We are trying to win the game."[23] "Clearly, it is possible, through technology, to make death optional."[24]

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[16] Jeff Bezos, June 2016, in *Amazon CEO Jeff Bezos: We Should Settle Mars 'Because It's Cool'*. Bezos is founder and owner of Blue Origin, an aerospace manufacturer sub-orbital spaceflight company. The company manufactures rocket engines, launch vehicles and cargo carriers. It is in the business of space tourism and is launching satellites into space for satellite Internet service providers (Nusca, 2016).

[17] Larry Ellison, August 2013, in *The Immortality Financiers: The Billionaires Who Want to Live Forever*. Ellison is co-founder, executive chairman, CTO and former CEO of Oracle Corporation. Oracle is one of the largest software corporations of the world. It sells database software, cloud-engineered systems and enterprise software (Gollner, 2013).

[18] Peter Thiel, November 2011, in *No Death, No Taxes: The libertarian futurism of a Silicon Valley billionaire*. Peter Thiel co-founded Paypal in 1998. Paypal merged with Elon Musk's x.com in 2000. In 2002 Paypal was acquired by eBay. Thiel used his earnings to create Clarium Capital Management, a global macro hedge fund (Packer, 2011).

[19] Peter Thiel, June 2015, in *Peter Thiel, N.T. Wright On Technology, Hope, And The End Of Death*. In 2003 Thiel founded Palantir Technologies, a big data analysis company. It provides data mining services to government intelligence agencies such as the CIA. Palantir also develops 'mission critical' software for the U.S. Immigration and Customs Enforcement (Anderson, 2015).

[20] Joon Yun, April 2017, in *Silicon Valley's Quest to Live Forever*. Yun is the creator of the Palo Alto Longevity Prize, launched in 2014. The prize aims to encourage the development of technologies that can regulate health and lifespan. Yun is also president of healthcare hedge fund Palo Alto Investors (Friend, 2017).

[21] Dmitry Itskov, January 2012, in the *'about' page of the 2045 Initiative*. Itskov is founder of New Media Stars, a Russian media company. In 2011 he founded the 2045 initiative, a transhumanist non-profit aiming to achieve cybernetic immortality by the year 2045 (2045, 2012).

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"Yes, our bodies are information-processing systems."[25] "Technology maps to miraculous supernatural creation, and globalization maps to naturalistic uniformitarian evolution. Technology involves the creation of radically new things that have not existed, and globalization maps to the continual copying of things that already exist."[26] "We can enable human transformations that would rival Marvel Comics. Super muscularity, ultra-endurance, super radiation-resistance. You could have people living on the moons of Jupiter who'd be modified in this way, and they could physically harvest energy from the gamma rays they were exposed to."[27] "[...] form a culture connected with the ideology of the future, promoting technical progress, artificial intellect, "multi-body", immortality, and cyborgization.” “We suggest the implementation of not just a mechanistic project to create an artificial body, but a whole system of views, values and technology which will render assistance to humankind in intellectual, moral, physical, mental and spiritual development.”[28]

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[22] Bill Maris, April 2017, in *Silicon Valley's Quest to Live Forever*. Maris is founder of Section 32, a venture fund investing in technology, bio-tech and health care companies. He is founder and CEO of Google Ventures, Alphabet's investment company focused on startups in the fields of Internet, software, healthcare, AI, transportation and cybersecurity (Friend, 2017).

[23] Bill Maris, June 2015, in *Who owns the future? How the prophets of Silicon Valley took control.* Maris is the creator of Alphabet's Calico Life Sciences, an R&D biotech company aiming at fighting aging and age related diseases. One of their research strands is using Machine Learning to analyse biological images (Harari, 2015).

[24] Martine Rothblatt, April 2017, in *Silicon Valley's Quest to Live Forever*. Rothblatt is founder and chairwoman of the board at United Therapeutics, a biotech company developing life-extending technologies such as organ manufacturing and treatments for lung disease (Friend, 2017).

[25] Jan Vijg, April 2017, in *Silicon Valley's Quest to Live Forever*. Vijg is Chairperson in Molecular Genetics at the Department of Genetics at the Albert Einstein College of Medicine. Before 2017 he was professor at the Buck Institute for Research on Aging, a non-profit biomedical research institute focussed on aging and age-related disease (Friend, 2017).

[26] Peter Thiel, November 2011, in *No Death, No taxes.* After Google stopped Project Maven, a secret artificial intelligence program aimed at the unmanned operation of aerial vehicles, after employees walking out, Palantir took over the contract with the Pentagon (Packer, 2011).

[27] Brian Hanley, April 2017, in *Silicon Valley's Quest to Live Forever*. Hanley is founder of Butterfly Sciences, aiming to develop gene therapy to treat HIV AIDS. Not wanting to wait for FDA approval of his rejuvenating gene therapy, he injected himself with analogues of the gene for growth-hormone-releasing hormone (GHRH) (Friend, 2017).

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“We are at the beginning of the beginning. The first hour of day one. There have never been more opportunities. The greatest products of the next 25 years have not been invented yet.” You are not too late.”[29] “Day 2 is stasis. Followed by irrelevance. Followed by excruciating, painful decline. Followed by death. And that is why it is always Day 1.” “The outside world can push you into Day 2 if you won’t or can’t embrace powerful trends quickly. If you fight them, you’re probably fighting the future. Embrace them and you have a tailwind.”[30] “We’re going to take over the world. One robot at a time [...]”[31] “It’s going to be an AI that is able to source, create, solve and answer just what is your desire. I mean this is almost a god like view of the future. [...] AI is going to be magic”[32] “What is going to be created will effectively be a god [...]” “It’s not a god in the sense that it makes lightning or causes hurricanes. But if there is something a billion times smarter than the smartest human, what else are you going to call it?” “The idea needs to spread before the technology [...]” “The church is how we spread the word, the gospel.

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[28] Dmitry Itskov, January 2012, in the *about page of the 2045 Initiative*. According to the 2045 Strategic Social Initiative milestones, between 2020 and 2025 human brains, after life has ended, would be transplanted into robotic avatars. The final milestone involves a hologram-like avatar to which a human personality can be transferred at the end of life (2045, 2012).

[29] Kevin Kelly, July 2016, in *The Next 30 Digital Years*. Kelly is founding executive editor of Wired Magazine and former editor and publisher of Whole Earth Review and co-founded the Whole Earth ’Lectronic Link (WELL) together with Stewart Brand. The Whole Earth Review was first published in 1985. The WELL was launched in the same year, and provided services such as forums, shell accounts and email to a virtual community (Long Now Foundation, 2016).

[30] Jeff Bezos, April 2017, in *2016 Letter to Shareholders*. Bezos bought The Washington Post in 2013 and co-founded Altos Labs in 2021, a biotech company developing longevity therapeutics. The lab’s goal is to to develop therapies that can halt or reverse the human aging process (Amazon News, 2017).

[31] Anthony Levandowski, September 2017, in *God Is a Bot, and Anthony Levandowski Is His Messenger*. Levandowski co-founded Waymo, Google’s self-driving car program. He also co-founded, and later sold Otto, a self-driving truck company, to Uber (Harris, 2017a).

[32] Peter Diamandis, December 2016, at the *Exponential Manufacturing Summit*. Diamandis is co-founder of Human Longevity, a company using machine learning on a database of human genotypes and phenotypes in the hope it will help fight disease related to aging. In 2018 he founded Celularity, a stemcell start-up offering placental cell therapy meant to augment a client’s longevity (Singularity University, 2016).

If you believe [in it], start a conversation with someone else and help them understand the same things."[33]

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"We're in the process of raising a god. So let's make sure we think through the right way to do that. It's a tremendous opportunity." "In Silicon Valley we use evangelism as a word for [promoting a business], but here it's literally a church." "There are many ways people think of God, [...] but they're always looking at something that's not measurable or you can't really see or control. This time it's different. This time you will be able to talk to God, literally, and know that it's listening."[34] "Computers are going to take over from humans, no question [...]" "But when I got that thinking in my head about if I'm going to be treated in the future as a pet to these smart machines ... well I'm going to treat my own pet dog really nice." "But in the end we just may have created the species that is above us."[35] "I understood that a lot of the technology we're making is a little scary and I've discovered that a very common reaction is to want to be afraid of things and to fear what's coming, and I found there was a different take on things which was that we should really embrace whats coming, because by embracing it, that was the best way we could actually steer it."[36] "Chaining it isn't going to be the solution, as it will be stronger than any chains you could put on [...]"[37] "AI is a fundamental existential risk for human civilization, and I don’t think people fully appreciate that [...]”[38] “[...] if you can’t beat them, join them.”[39] “Do you want to be a pet or livestock?”[40] “I don’t love the idea of being a house cat, but what’s the solution? I think one of the solutions that seems maybe the best is to add an AI layer, a third, digital layer that could work well and symbiotically.” “If we can create a high-bandwidth neural interface with your digital self, then you’re no longer a house cat.”[41]

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[33] Anthony Levandowski November 2017, in *Inside the First Church of Artificial Intelligence*. In 2017 Levandowski founded Way of the Future (WOTF), the first church of AI. The church's website went offline in April 2020. Four months later Levandowski admitted to theft of self-driving car trade secrets when leaving Waymo. He spend 18 months in prison and was pardoned on Trump's last day of his first presidency (Harris, 2017b).

[34] Anthony Levandowski November 2017, in *Inside the First Church of Artificial Intelligence*. In February 2022, Levandowski founded Pollen Mobile, a distributed wireless network used by Pronto AI's autonomous vehicles (Harris, 2017b).

[35] Steve Wozniak, March 2015, in *Apple co-founder Steve Wozniak on the Apple Watch, electric cars and the surpassing of humanity*. Wozniak is co-founder of Apple, a multinational tech company focused on consumer electronics, online services and software. It is the largest tech company by revenue and since 2021 the world's most valuable (Smith, 2015).

[36] Kevin Kelly, March 2016, in *12 Inevitable Tech Forces That Will Shape Our Future* at SXSW. In 1992 Kelly was hired to serve as executive editor of Wired, which published its first issue the next year. Kelly brought his utopian cybernetic visions to Wired, and brought in writers from the WELL. In 1999 he stepped down and became Senior Maverick (SXSW, 2016).

[37] Anthony Levandowski, November 2017, in *Inside the First Church of Artificial Intelligence*. In 2018 Levandowski launched Pronto AI, initially to produce camera-based, self-driving semi-trucks. After Levandowski's release from prison, he announced the company would focus on producing autonomous haul trucks for mining (Harris, 2017b).

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“No human is involved in writing this code.” “At the end of the optimization we’re left with large networks that work well, but it’s very hard to tell how. Across many applications areas, we’ll be left with a choice of using a 90% accurate model we understand, or 99% accurate model we don’t.”[42] “History has shown us we aren’t going to win this war by changing human behavior. But maybe we can build systems that are so locked down that humans lose the ability to make dumb mistakes. Until we gain the ability to upgrade the human brain, it’s the only way.”[43] “Let’s stop pretending we can hold back the development of intelligence when there are clear massive short term economic benefits to those who develop it and instead understand the future and have it treat us like a beloved elder who created it."[44]

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[38] Elon Musk, July 2017, in *Elon Musk Warns Governors: Artificial Intelligence Poses ‘Existential Risk’*. Musk co-founded Open AI, a for-profit corporation with a non-profit parent company, with the aim of developing and promoting friendly AI. In 2018 Musk resigned from the board because of a possible future conflict of interest with Tesla’s AI development for self-driving cars. Musk is CEO and largest shareholder of Tesla (Domonoske, 2017).

[39] Elon Musk, July 2020, in a tweet. On April 25th 2022, Musk bought Twitter for 43 billion dollar, now owning 100% of the stock, taking the company private. He aims to unlock the company by enhancing it with new features (Musk, 2020).

[40] Anthony Levandowski, November 2017, in *Inside the First Church of Artificial Intelligence.* Because Pronto AI needed cheap mobile connectivity for their autonomous vehicles, it launched Pollen Mobile. It incentivises its users with cryptocurrency to run their own mini cell towers in order to expand the network’s coverage. Cell towers are called flowers, and flower operators earn PollenCoin depending on quality, coverage and data transmitted. Operators pay the costs of the cell tower themselves and of course their home internet connection which the network is relying on (Harris, 2017b; Korosec and Matney, 2022).

[41] Elon Musk, June 2016, in *Elon Musk thinks we need brain-computers to avoid becoming ‘house cats’ to artificial intelligence.* Musk is CEO and co-founder of Neuralink, a neurotechnology company developing brain-machine interface implants. The goal is to develop devices for human enhancement, inspired by neural lace, a device from a fictional universe in books by Iain M. Banks. Neuralink tests their devices on live monkeys, pigs and other animals (D’Onfro, 2016).

[42] Andrej Karpathy, November 2017, in *Software 2.0.* Karpathy is director of AI and Autopilot Vision at Tesla. Tesla manufactures electric vehicles, battery energy storage, solar panels and solar roof tiles. Karpathy did his PhD at Stanford under the supervision of Fei-Fei Li, the leading investigator of ImageNet. Karpathy’s research focused on natural language processing and computer vision (Karpathy, 2017).

[43] Christopher Mims, January 2016, in *How to Improve Cybersecurity? Just Eliminate the Human Factor*. Mims is a tech columnist at The Wall Street Journal (Mims, 2016).

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"As a company, one of our greatest cultural strengths is accepting the fact that if you're going to invent, you're going to disrupt"[45] "I sort of have a single 'idee fixe' that I'm obsessed with and on the business side and it is that if you're starting a company, if you're an entrepreneur, a founder starting a company, you always want to aim for monopoly, and you want to always avoid competition. Hence: competition is for losers."[46] "[...] Progress is happening because there's an economic advantage to having machines work for you and solve problems for you. If you could make something one percent smarter than a human, your artificial attorney or accountant would be better than all the attorneys or accountants out there. You would be the richest person in the world. People are chasing that."[47] "AI"[48] "[...] the term has become more of a broad, almost marketing-driven term. And I'm probably okay with that. What matters is what people think of when they hear this."[49] "We are committed to always doing better, even if that involves building a worldwide voting system to give you more voice and control." "My hope is that more of us will commit our energy to building the long term social infrastructure to bring humanity together."[50] "We are in a deadly race between politics and technology... The fate of our world may depend on the effort of a single person who builds or propagates the machinery of freedom that makes the world safe for capitalism."[51]

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[44] Anthony Levandowski, November 2017, in *Way of the Future.* In 2020 the US Federal Motor Carrier Safety Administration denied an application from Pronto AI requesting an exemption from the 11-hour driving limit and the 14-hour driving window for their vehicles equipped with Pronto's advanced driver assistance systems (Levandowski, 2017).

[45] Jeff Bezos, November 2011, in *Jeff Bezos Owns the Web in More Ways Than You Think.* As per market share in 2021, Amazon is the world's largest online retailer, smart speaker provider, cloud computing service (AWS), live-streaming service (Twitch) and Internet company (Levy, 2011).

[46] Peter Thiel, autumn 2014, in *How to Start a Startup 2014: 5: Competition is for Losers.* In 2004 Thiel made an angel investment in Facebook and became a board member. In 2012 he sold most of his stock and in 2022 he announced leaving the board to support Trump-aligned candidates in the 2022 U.S. elections (Y Combinator, 2014).

[47] Anthony Levandowski, November 2017, in *Inside the First Church of Artificial Intelligence.* In 2021 Levandowki realised that the scientific breakthroughs that would enable driverless cars and trucks on public roads are still missing, and decided to pivot his company Pronto AI towards mining instead. Pronto AI charges 80% of what it would cost a mine to hire human drivers for the first 1500 hours of operations and 70% after that. The payback for the mine is almost instantaneous. Pronto AI keeps ownership over the hardware (Harris, 2017b; Efrati, 2021).

[48] Google, Facebook, Apple, Uber, Amazon, Microsoft, Unity Technologies, Palantir, Neuralink, Tesla, Goldman Sachs, Oracle, ...

[49] Danny Lange, November 2017, in *The AI Guru Behind Amazon, Uber, and Unity Explains What AI Really Is.* Lange is a computer scientist working on machine learning for companies such as Amazon Web Services, Microsoft, Uber, Unity and IBM. At Unity he works on artificial intelligence and machine learning for AR and VR (Captain, 2017).

"The idea needs to spread before the technology [...]"[52] "We are proudly capitalistic. I'm not confused about this."[53] "Let us celebrate capitalism [...]"[54]

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[50] Mark Zuckerberg, February 2017, in *Building Global Community*. Meta Platforms is a multinational tech corporation, parent to Facebook, Instagram, WhatsApp and has acquired Giphy, Oculus and Mapillary, Kustomer and Presize. 97% of it's revenue stems from the sale of advertisement placement (Zuckerberg, 2017)

[51] Peter Thiel, April 2009, in *The Education of a Libertarian*. In addition to Facebook, Thiel invested in many startups, such as Airbnb, LinkedIn, Spotify, SpaceX and TransferWise. In 2017 he invested in Clearview AI, a facial recognition tech startup that has raised concerns over potential weaponisation and has been the target of multiple lawsuits related to violation of privacy and safety regulations (Thiel, 2009).

[52] Anthony Levandowski, November 2017, in *Inside the First Church of Artificial Intelligence*. Levandowski got pardoned by Trump without having started his prison sentence due to the COVID-19 pandemic. The White House mentioned 13 supporters of his pardon, among who Peter Thiel and Palmer Luckey, the founder of Oculus and Anduril, providing AI technology for border surveillance (Harris, 2017b; Paul and Wong, 2021).

[53] Eric Schmidt, December 2012, in *Google boss: I'm very proud of our tax avoidance scheme*. Schmidt was CEO and later executive chairman of Google, executive chairman and later technical advisor at Alphabet. Schmidt was hired in 2001 by Google founders Larry Page and Sergey Brin. When in 2012, Google was being called unethical for their use of artificial distinctions to avoid paying billions of corporate taxes in the UK, Schmidt called it capitalism and stated he was very proud of it (Kumar and Wright, 2012).

[54] Eric Schmidt, March 2014, in *Google's Eric Schmidt: 'let us celebrate capitalism'*. In response to protests in the Bay Area against growing inequality, of which Google has become the symbol of, Schmidt proposed fast growing startups that generate lots of jobs as a solution. When confronted with the case of WhatsApp, that was acquired by Facebook for 19 billion dollars, yet only employed 50 people, Schmidt suggested celebrating capitalism: "$19 billion for 50 people? Good for them" (Jeffries, 2014).

A Tale of Two Data Centers

Welcome to the written version of *A Tale of Two Data Centers.*[1] This text was originally a short lecture-performance given on a bus from Amsterdam to Middenmeer, as part of *The Hmm's Data Centre Tour* which I co-curated with Lilian Stolk and Sjef van Beers. The tour took place the 23rd of September 2023, a day that started with rain and ended with sunshine and epic cloudscapes. There were 60 people on the bus.[2]

The tour started with the story I will share with you below, a reconstruction of how two hyperscale data centers from US multinationals Google and Microsoft arrived in the tiny rural municipality of Hollands Kroon, the Netherlands. After that, local councillor Lars Ruiter spoke about his personal experience of the flawed and opaque local political process which made the arrival of the hyperscalers possible. Anthropologist Miriyam Aouragh from TITiPI (The Institute for Technology in the Public Interest), researcher and designer Cristina Cochior and artist and designer Nazanin Karimi from Varia organised cloud resistance with fabric Faraday cages around everyone's phone, blocking the cloud from infiltrating our pockets and inviting everyone to contemplate what such a radical disconnection meant to them. Graphic designer and artist Lukas Engelhardt spoke of his *Homebrew Server Club* inspired practice of self-hosting, a resistance, and radically different approach to serving online content. Architect Paul Cournet, in collaboration with architect and researcher Negar Sanaan Bensi, gave an introduction to the architecture of data centres while walking alongside Microsoft's AMS05, AMS06, AMS08, AMS09, AMS11 and AMS12 data centres.

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[1] The research is based on news articles, publicly available online information, documents made public via a Freedom of Information Act request by journalists in 2020 (available on request at the municipality of Hollands Kroon), an interview with councillor in the municipality of Hollands Kroon Lars Ruiter and an interview with a member of Extinction Rebellion Almere (Ruiter, 2023; XR Almere, 2023).

[2] *The Hmm's Data Centre Tour* was repeated on the 9th of November 2024, this time with artist and educator Leo Scarin, artist-researchers anna andrejew and Ola Bonati, myself and councillor Lars Ruiter.

A Tale of Two Datacenters

This tale unfolds on artificial land. The Wieringermeer used to be a lake with the island Wieringen in it. In 1927, the lake was dried, because of the increased need for fertile agricultural land to grow the Dutch food supply. In 1934 it was ready for use. A whole slew of urban developers and sociologists worked at creating the perfect, politically stable and economically productive polder (Mansholt, 1940, figure 5.16).

It all went swimmingly, until April 17, 1945, when the Nazi's blew up the dike protecting it, the polder was flooded and all buildings and crops were destroyed (Arbeiderspers, 1945, figure 5.17). Seven months later the polder was dry again and the rebuilding could commence. Sociologist Sjoerd Groenman thought that the villages should remain small, because in bigger villages the workers would be able to gain too much power, they would turn into hotbeds of insurgent activity (Groenman, 1948; van Woensel, 1999). To avoid such trouble, 3 equally sized villages were reconstructed, each farmer carefully selected, with equal amounts of Protestants, Catholics and Reformists, on equally priced and sized patches of leased land.

This carefully planned polder remained quite the same for 60 years; a small, agrarian municipality, the most sparsely populated one of the country, with as main economic activity agriculture: potato, wheat, sugar beet and dairy farming. Until 2005.

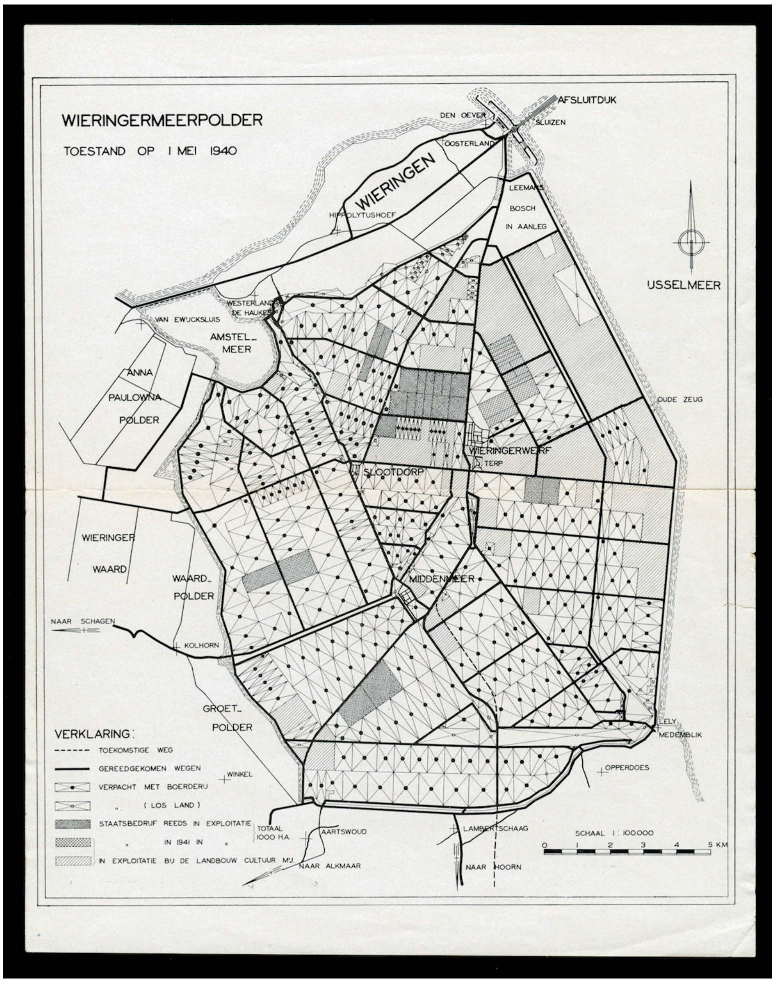
WIERINGERMEERPOLDER
TOESTAND OP 1 MEI 1940
AFSLUITDIJK
DEN OEVER
SLUIZEN
OOSTERLAND
WIERINGEN
HIPPOLYTUSHOEF
LEEMANS BOSCH IN AANLEG
IJSSELMEER
WESTERLAND
DE HAUKES
VAN EWIJCKSLUIS
AMSTEL_ MEER
ANNA PAULOWNA POLDER
OUDE ZEUG
WIERINGERWERF
TERP
SLOOTDORP
WIERINGER WAARD
WAARD_ POLDER
MIDDENMEER
NAAR SCHAGEN
KOLHORN
GROET_ POLDER
LELY
MEDEMBLIK
OPPERDOES
WINKEL
VERKLARING:
TOEKOMSTIGE WEG
GEREEDGEKOMEN WEGEN
VERPACHT MET BOERDERIJ
" (LOS LAND)
STAATSBEDRIJF REEDS IN EXPLOITATIE
" IN 1941 IN "
IN EXPLOITATIE BIJ DE LANDBOUW CULTUUR MIJ.
TOTAAL 1000 H.A.
AARTSWOUD
NAAR ALKMAAR
LAMBERTSCHAAG
NAAR HOORN
SCHAAL 1 : 100.000
0 1 2 3 4 5 KM

Figure 5.16: Mansholt, S.L. (1940) *Wieringermeerpolder: toestand op 1 mei 1940* [Map]. The map depicts the polder with its rectangular lots and three villages. Via Archief Sicco Leendert Mansholt. Public domain.

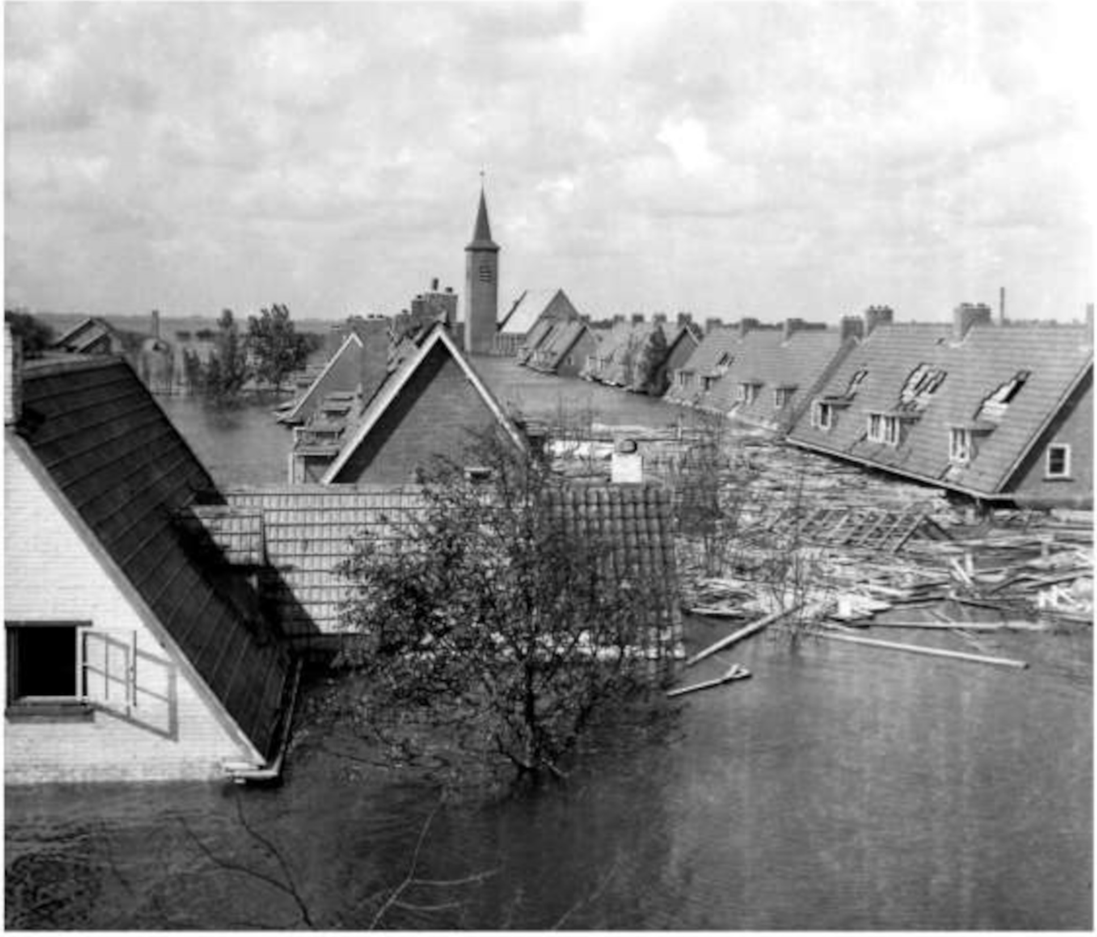

Figure 5.17: Arbeiderspers (1945) *Drijfhout* [Photograph]. The flooding of the Wieringermeer polder. Public domain.

2005

In 2005, the business Agriport A7, an agricultural business park, is started by Anton Hiemstra. The company began buying out farmers and transforming the farmland into construction lots, including heavy infrastructure to accommodate industrial scale greenhouses (Houtekamer and Rengers, 2020). The municipality adjusted the zoning plan of 950 hectares of agricultural land to accommodate Agriport (Beeldbank Historisch Genootschap Wieringermeer, 2007, figure 5.18).

2006

At the start of 2006, when the first industrial horticulture companies arrives at Agriport, the Energie Combinatie Wieringermeer (ECW energy) is created, a private energy company, collectively owned by the horticulture businesses at Agriport. It is an electricity network operator, energy producer and energy broker, with its own network of cables, production and storage facilities (ECW Energy, 2023b, see figure 5.19).

To heat those enormous greenhouses, each business has a Combined Heat and Power (CHP) plant, a natural gas powered combustion engine powering a dynamo that generates heat and CO_2 for crops such as tomatoes and peppers and electricity the farmers do not need themselves.[3] ECW then sells this surplus energy on the market through its connection to Tennet's national power grid at the Middenmeer substation.[4] ECW has a lot of energy on offer and is therefore in need of a large consumer. An intern suggests a data center would be a good fit (Eerenbeemt, 2019; Houtekamer and Rengers, 2020).

2007

September 2007, Internet entrepreneurs Pieter Duijves and Kevin Burton start Parthenon Data Centres. They realise the demand for data centers is growing rapidly, but few new ones are build due to a lack of electricity supply. The required infrastructure cannot be ramped up quickly enough. Government and EU regulations and the construction itself make this a slow process (van Bentum, 2009b). They start looking at alternative possibilities and discover that greenhouses generate surplus electricity and also have a high demand for heating, a perfect match for data centres that need a lot of electricity and also produce residual heat through their cooling systems (figure 5.22 and 5.21). They start writing a business plan for a 'sustainable', yet fossil fuel powered, data center (van Bentum, 2009b).[5]

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[3] The electricity network of Agriport ran on gas from Groningen until 2022 (Eerenbeemt, 2019).

[4] TenneT is an electricity transmission operator in the Netherlands, controlled and owned by the Dutch government. It operates the high voltage grid and substations that transform high voltage to low voltage and connect to the regional low voltage network operated by Liander.

Figure 5.18: Beeldbank Historisch Genootschap Wieringermeer (2007) *Aanleg kassen* [Photograph]. The construction of greenhouses on the Tussenweg. Via Beeldbank Historisch Genootschap Wieringermeer.

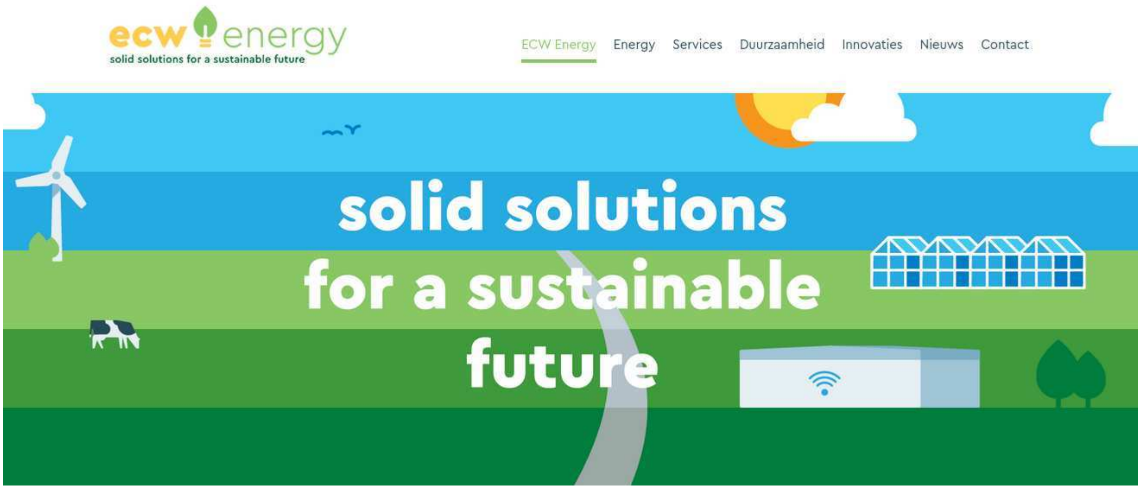
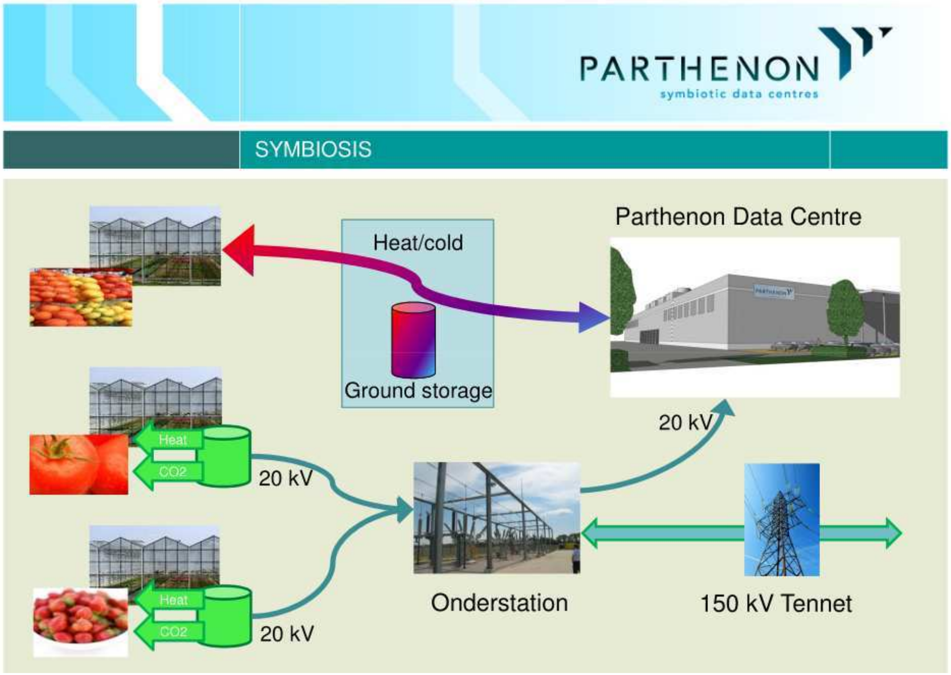

ecw energy
solid solutions for a sustainable future
ECW Energy
Energy
Services
Duurzaamheid
Innovaties
Nieuws
Contact
solid solutions
for a sustainable
future

Figure 5.19: Homepage of ECW Energy (ECW Energy, 2023b).


PARTHENON
symbiotic data centres

SYMBIOSIS

Heat/cold

Ground storage

Parthenon Data Centre

Heat

CO2

20 kV

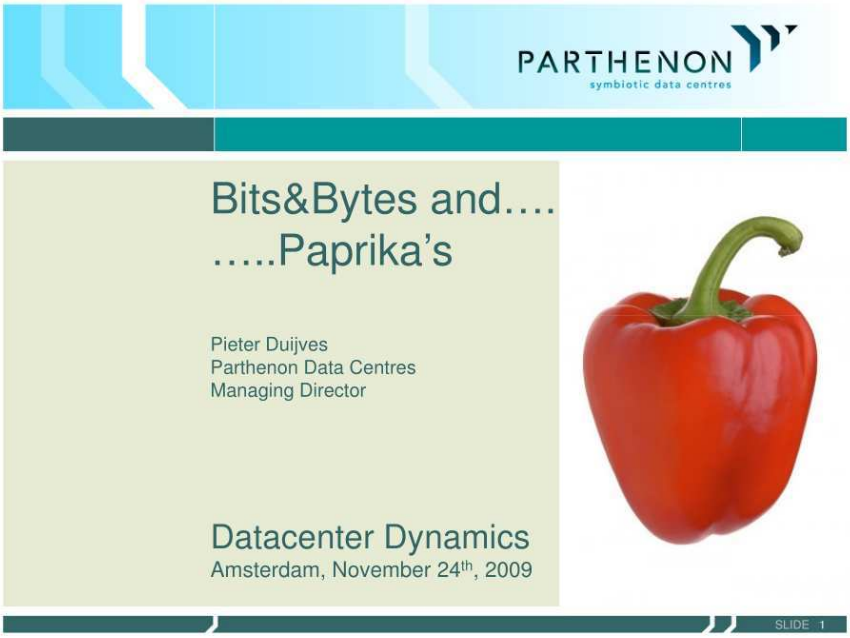
20 kV

20 kV

Onderstation

150 kV Tennet

Figure 5.20: Slide from the presentation *Bits&Bytes and...Paprika's* by Pieter Duijves at Datacenter Dynamics, November 2009 (Duijves, 2009).



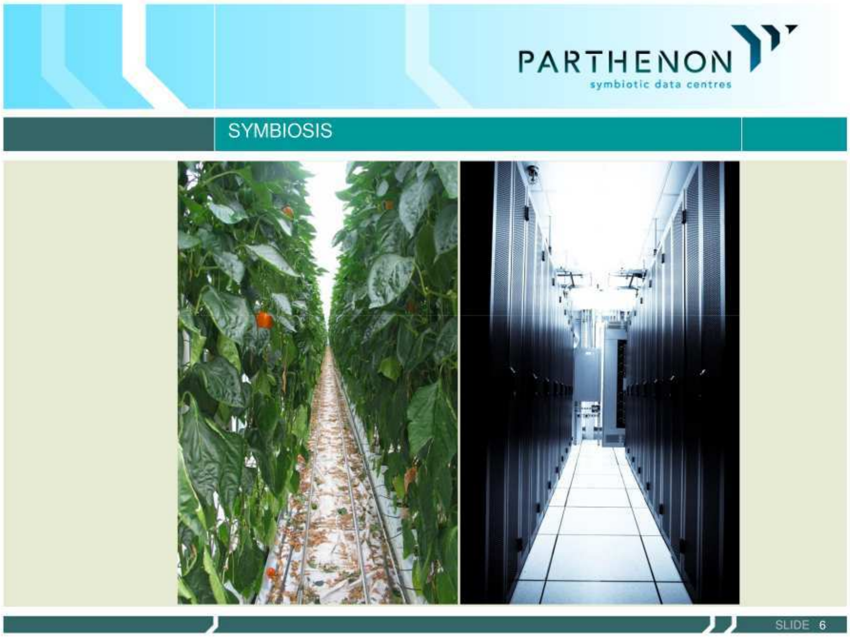
PARTHENON
symbiotic data centres

Bits&Bytes and….
…..Paprika's

Pieter Duijves
Parthenon Data Centres
Managing Director

Datacenter Dynamics
Amsterdam, November 24th, 2009

Figure 5.21: Slide from the presentation *Bits&Bytes and...Paprika's* by Pieter Duijves at Datacenter Dynamics, November 2009 (Duijves, 2009).



PARTHENON
symbiotic data centres

SYMBIOSIS

Figure 5.22: Slide from the presentation *Bits&Bytes and...Paprika's* by Pieter Duijves at Datacenter Dynamics, November 2009 (Duijves, 2009).

INVEST IN Holland
NEWS
SEARCH
MENU
ENGLISH
CONTACT
About NFIA
Home • How We Help • About NFIA

Figure 5.23: Homepage of the Netherlands Foreign Investment Agency (NFIA, 2023).

2008

In 2008, the ‘InnovatieNetwerk’ think tank (initiated by the Ministery of Agriculture, Nature and Fishery) get Parthenon Data Centers in touch with Agriport A7. The municipality of Wieringermeer and Parthenon negotiate to change the zoning plan to accommodate a 2 hectare sized data center. Parthenon promises cross-sector sustainability (van Bentum, 2012). The framing of electricity as a ‘waste product’ of the greenhouses, and so-called ‘circularity’, worked wonders. A great deal of media attention is generated, with wordings such as “pepper flavored data”, “datacenter helps peppers’s grow” and eventually the “pepper datacenter” (van Bentum, 2009b, 2013; 2009a).

Parthenon however, chooses Agriport because (1) it is the only place that can ramp up its electricity supply fast enough to accommodate a new data centre (van Bentum, 2009b), (2) it has a fibre optic network and is close to the Amsterdam Internet Exchange, the second largest in the world, ensuring excellent connectivity, (3) it promises Duijves exclusivity, no other data centers are allowed in the area (van Bentum, 2009b) and (4) it provides a competitive edge, in the shape of cheap electricity.[6] This profitable yet energy hungry

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[5] It is unclear if Duijves and Burton were the first with this idea. The idea also occurred to an employee at a data centre of the Ministry of Defence, which was looking to expand its data centre close to the greenhouses in the Westland of the Netherlands.(van Bentum, 2009d)

[6] ECW Energy planned an expansion of its electricity grid with two 150kV-transformers making a double connection to a high-voltage grid possible, to Tennet as well as ECW, meaning that if there is a power cut on the national grid, ECW can provide a sort of electricity island that is still up and running.(ECW Energy, 2023a)

plan was marketed through increasingly circular thinking, reaching its peak in 2015 when Agriport's CEO Jack Kranenburg told FDI Intelligence:

> "When you think you're working on your computer, you're actually growing peppers at Agriport." (Turak, 2015)

2009

In parallel to Parthenon's plans in Middenmeer, Microsoft is looking to expand its data center capacity in Europe. From 2009 onwards, the Netherlands Foreign Investment Agency (NFIA), a branch of the Ministry of Economic Affairs and Climate, is actively involved in bringing Microsoft data centers to the Netherlands (Tweede Kamer der Staten-Generaal, 2023). In October 2009 a working group investigates the feasibility of delivering residual heat to greenhouses. The farmers were enthusiastic about the potential purchase of their energy, but weren't as happy about the substantial investments needed to provide the infrastructure for this plan to work (van Bentum, 2009c).

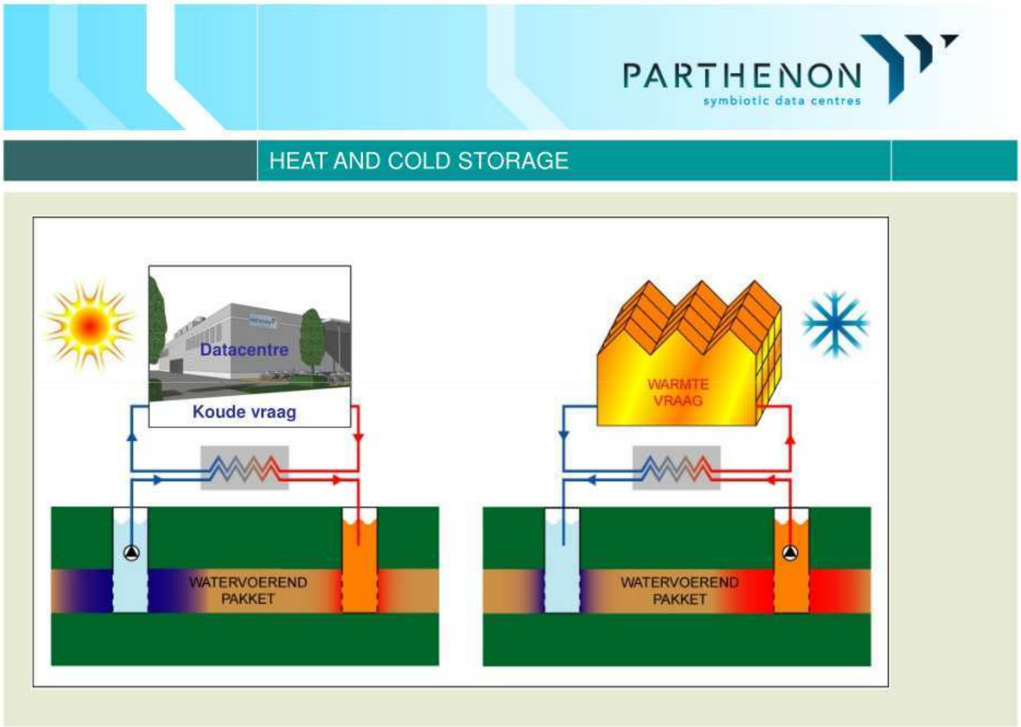
The problem, the working group realised, is that even though greenhouses need heat, and data centers need cooling, they need it at radically different times of the year (figure 5.24). Residual heat can be stored underground but this is the massive infrastructural investment the farmers aren't willing to make. Duijves still believes it is feasible for large scale projects (van Bentum, 2009d).

Parthenon's director Duijves tells James Hayes, editor of *Engineering and Technology*:

> "The world's IT giants have expressed serious interest in this unique Dutch design... it could become a Dutch export item." (Hayes, 2009)

2010

January 2010 Parthenon buys a plot at Agriport and aims at quickly starting the construction of 'the world's greenest datacenter' (Driessen, 2009). In the background, the NFIA and Development Agency Noord-Holland Noord (NHN) are working hard at wheeling

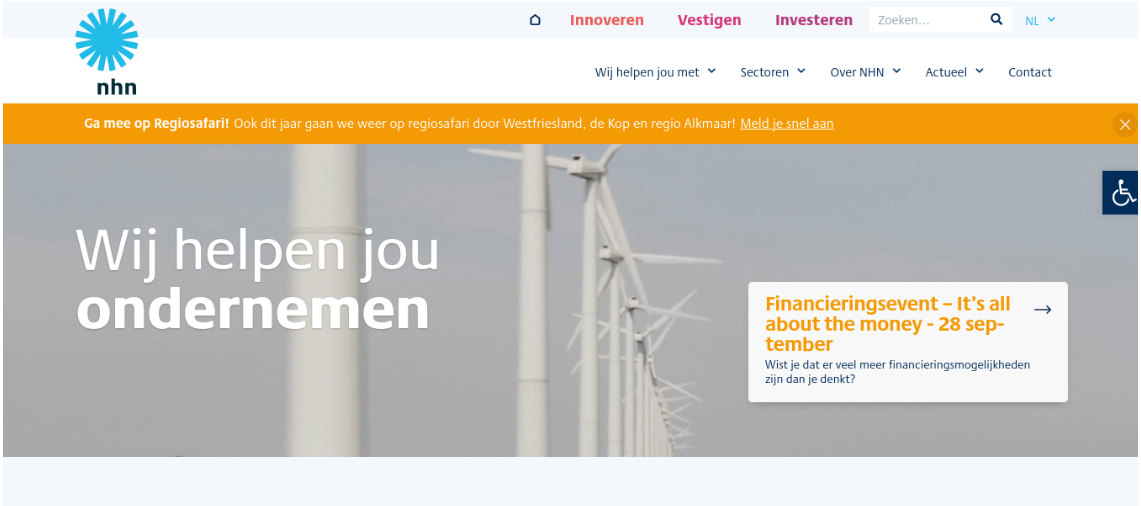


PARTHENON
symbiotic data centres

HEAT AND COLD STORAGE

Datacentre
Koude vraag
WATERVOEREND PAKKET
WARMTE VRAAG
WATERVOEREND PAKKET

Figure 5.24: Slide from the presentation *Bits & Bytes and...Paprika's* by Pieter Duijves at Datacenter Dynamics, November 2009 (Duijves, 2009).



nhn
Innoveren
Vestigen
Investeren
Zoeken...
NL
Wij helpen jou met
Sectoren
Over NHN
Actueel
Contact

Ga mee op Regiosafari! Ook dit jaar gaan we weer op regiosafari door Westfriesland, de Kop en regio Alkmaar! Meld je snel aan

Wij helpen jou
ondernemen

Financieringsevent – It's all about the money - 28 september

Wist je dat er veel meer financieringsmogelijkheden zijn dan je denkt?

Figure 5.25: Homepage of Development Agency Noord-Holland Noord (Ontwikkelingsbedrijf Noord-Holland Noord, 2023).

in Microsoft. Bjorn Borgers, from NHN, recalls (figure 5.25).

> “Back in 2010, after a visit from the data centre project team, we asked our municipality to change the zoning plan to accommodate a large company requiring a large piece of land, [...] We could not tell them who the company was, but they produced the plan and the process four years later was a very quick one.” (Turak, 2015)

So much for Parthenon’s exclusivity deal.

2011

In February 2011 Parthenon announces the construction of its data center is postponed (van Bentum, 2011).

2012

In April 2012 Parthenon announces its ‘paprika datacenter’ is cancelled due to a lack of investors (van Bentum, 2012).

2013

In September 2013, Theo Meskers, a VVD alderman in Hollands Kroon, Anton Hiemstra, owner of Agriport, a VVD deputy of the province of Noord-Holland, two representatives of NHN and a representative of the Ministry of Economic Affairs are on an airplane to Microsoft’s headquarters in Seattle to convince them to come to Hollands Kroon. But they don’t need convincing, even before arriving at HQ, Meskers receives a text message from Microsoft confirming the deal (Houtekamer and Rengers, 2020; Gemeente Hollands Kroon, 2023). Microsoft demands its involvement be kept strictly secret until all permits are arranged (Ruiter, 2023).

2014

In June 2014, NHN presents *Made in Holland – Datacenters* in which they explain why Hollands Kroon is such a great place for datacenters (figure 5.27). The main reason for locating there is spot on:

> "Soon the mainframes, clusters, and racks will be humming with the electricity from the greenhouses. And because the electricity comes directly from the neighbours, the IT companies can save on their energy costs." (Ontwikkelingsbedrijf Noord-Holland Noord, 2014)

In December 2014 the first draft of a changed zoning plan is submitted, dedicating not 2 but 70 hectares to data centers at Agriport (Gemeente Hollands Kroon, 2014). The procedures are indeed completed very quickly.

2015

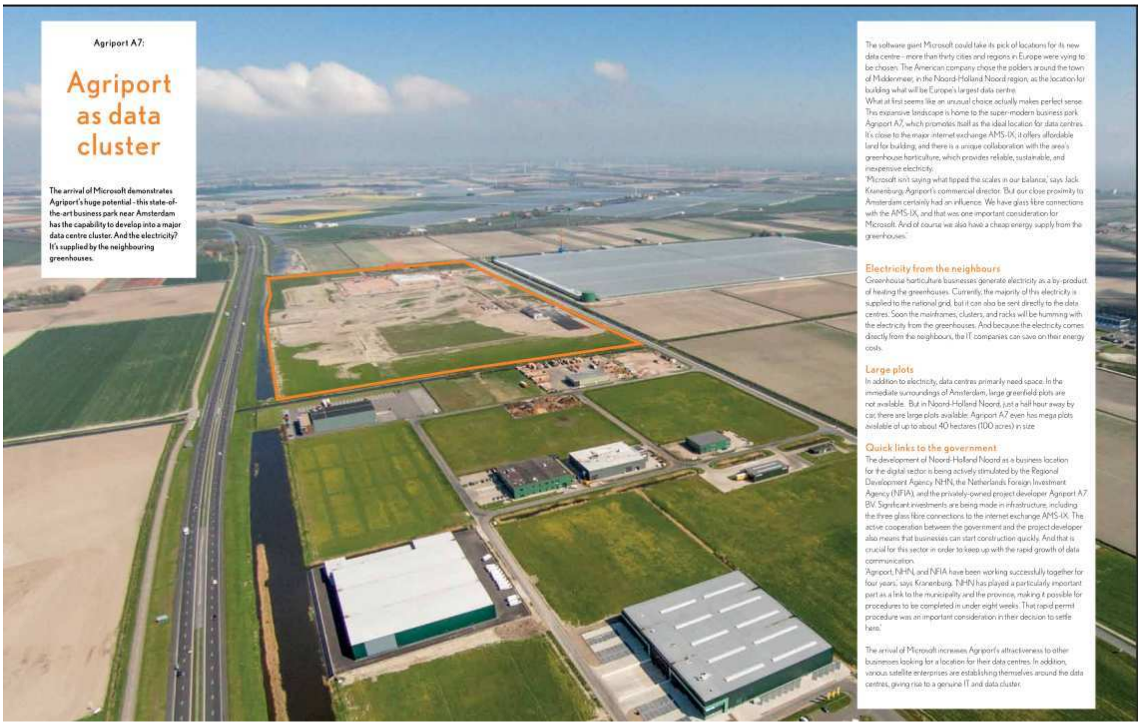
In 2015 the first two Microsoft data centers are constructed. There are no requirements for Microsoft to make any infrastructural investments for residual heat coupling. AMS05 is finished (figure 5.28).

2016

In November 2016 the Crisis and Recovery law is used to allow for even faster inclusion of data centers within zoning plans. Included is the new plan for Agriport A7, again framed within the realms of circular economy and sustainability. The text reads:

> "Sustainability, energy, synergy and circular economy are important foundations for the further development of the terrain. The aim is closed and optimal cycles, in which waste from one company are input for another. For example, the residual heat from a data center is reused for the heating of the greenhouses. This synergy is already in full motion at Agriport. [...]" (Ministerie van Infrastructuur en Milieu, 2016)

Figure 5.26: Coolcaesar (2016) *Building 92 at Microsoft Corporation headquarters in Redmond, Washington.* [Photograph]. CC-BY-SA 4.0.



Agriport A7:

Agriport as data cluster

The arrival of Microsoft demonstrates Agriport's huge potential - this state-of-the-art business park near Amsterdam has the capability to develop into a major data centre cluster. And the electricity? It's supplied by the neighbouring greenhouses.

The software giant Microsoft could take its pick of locations for its new data centre – more than thirty cities and regions in Europe were vying to be chosen. The American company chose the polders around the town of Middenmeer, in the Noord-Holland Noord region, as the location for building what will be Europe's largest data centre.

What at first seems like an unusual choice actually makes perfect sense. This expansive landscape is home to the super-modern business park Agriport A7, which promotes itself as the ideal location for data centres. It's close to the major internet exchange AMS-IX; it offers affordable land for building; and there is a unique collaboration with the area's greenhouse horticulture, which provides reliable, sustainable, and inexpensive electricity.

'Microsoft isn't saying what tipped the scales in our balance,' says Jack Kranenburg, Agriport's commercial director. 'But our close proximity to Amsterdam certainly had an influence. We have glass fibre connections with the AMS-IX, and that was one important consideration for Microsoft. And of course we also have a cheap energy supply from the greenhouses.'

Electricity from the neighbours

Greenhouse horticulture businesses generate electricity as a by-product of heating the greenhouses. Currently, the majority of this electricity is supplied to the national grid, but it can also be sent directly to the data centres. Soon the mainframes, clusters, and racks will be humming with the electricity from the greenhouses. And because the electricity comes directly from the neighbours, the IT companies can save on their energy costs.

Large plots

In addition to electricity, data centres primarily need space. In the immediate surroundings of Amsterdam, large greenfield plots are not available. But in Noord-Holland Noord, just a half hour away by car, there are large plots available. Agriport A7 even has mega plots available of up to about 40 hectares (100 acres) in size.

Quick links to the government

The development of Noord-Holland Noord as a business location for the digital sector is being actively stimulated by the Regional Development Agency NHN, the Netherlands Foreign Investment Agency (NFIA), and the privately-owned project developer Agriport A7 BV. Significant investments are being made in infrastructure, including the three glass fibre connections to the internet exchange AMS-IX. The active cooperation between the government and the project developer also means that businesses can start construction quickly. And that is crucial for this sector in order to keep up with the rapid growth of data communication.

'Agriport, NHN, and NFIA have been working successfully together for four years,' says Kranenburg. 'NHN has played a particularly important part as a link to the municipality and the province, making it possible for procedures to be completed in under eight weeks. That rapid permit procedure was an important consideration in their decision to settle here.'

The arrival of Microsoft increases Agriport's attractiveness to other businesses looking for a location for their data centres. In addition, various satellite enterprises are establishing themselves around the data centres, giving rise to a genuine IT and data cluster.

Figure 5.27: Detail from the brochure *Made in Holland: Datacenters*, (Ontwikkelingsbedrijf Noord-Holland Noord, 2014).

This synergy is not at all in motion, not in 2016, not now. None of the large infrastructural investments needed for meaningful heat exchange have been made.

2017

In 2017 AMS07 and AMS08 are finished. In September 2017 the energy company Vattenfall announce the scaling up of its Dutch wind energy projects. Vattenfall offered 32 local farmers 3,3 million euro each for the right to build a mega wind turbine on their land (Houtekamer and Rengers, 2020). At the end of the year Vattenfall announces that all energy from the park that is under construction will go to Microsoft's data center. The website of the windpark still states the energy is for 370.000 households (Houtekamer and Rengers, 2020).

2018

In 2018 AMS11 en AMS12 are finished. Still no residual heat infrastructure requirements. February 2018 Google signs a deal with Hiemstra. May 2018, the council is introduced to Google under strict secrecy, they do not know the land has already been sold. In all communications the code name 'Nimble' is used to keep Google's involvement secret. November 2018 alderman Theo Meskers receives an email exchange with an advisor at the council of Hollands Kroon (Gemeente Hollands Kroon, 2018). The advisor warns Theo about a memo containing a false piece of information about the use of residual heat:

> "I've asked around about this [blanked] and this was once the intention but in practice it turned out to be impossible. That's why the residual heat is unfortunately just blown into the air... I've seen this more often and it is important for you to know that this is no longer correct. I would scratch that passage from the memo." (Gemeente Hollands Kroon, 2018)

To which Theo Meskers replies:

> "The connection between 'greenhouse agriculture XXL' and hyperscale data

> centers must be made, otherwise the data-entrepreneurs lose public support, is my assumption. So it is important for all parties, that the connection is made. [...] Greetings, Theo." (Gemeente Hollands Kroon, 2018)

2019

In May 2019, finally, 10 years after the start of the lobby efforts of NFIA on behalf of the Ministry of Economic Affairs and Climate, the House of Representatives publishes a roadmap for the growth of data centers in the Netherlands (Weerwind and Steembakkers, 2019). In the report, the rapid growth in demand for electricity is at long last recognised as a major bottleneck but then suggests facilitating the arrival or more energy hungry data centers by using the Climate Agreement to speed up new connections to the grid (Ministerie van Economische Zaken en Klimaat, 2019).[7] On top of that, supporting statements such as: "A quarter of Dutch Gross National Product depends on data centers" are based on the information provided by three data center lobby groups (Ministerie van Economische Zaken en Klimaat, 2019, p. 10).[8]

2020

May 2020, the development plan of Agriport is discussed during two council meetings. It becomes clear that the assembly had kept a running list of data centers secret for seven months and only made it public in October. The opposition is shocked (Gemeente Hollands Kroon, 2020b). The existing 60 hectares of data centers would be expanded to a total of 230 (Gemeente Hollands Kroon, 2021b).[9]

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[7] The report suggests that for residual heat reuse to take place, large scale data centers should be placed in urban centers, leaving out the reasons why multinationals choose for rural locations.

[8] Dutch Data Center Association (DDA), Dutch Hosting Provider Association (DHPA) and ISPConnect.

[9] This translates to an enormous increase in fossil fuel use, as can be learned from a January 2020 report on the growth strategy of data centers in the Haarlemmermeer and Amsterdam commissioned by the city council of Amsterdam (Buck Consultants International and CE Delft, 2020). The report concludes that organisation and market regulation of new infrastructures is completely lacking on all levels of government. It also warns that expansion means scaling up electricity production, which currently means an increase in CO_2 emissions because the largest part of electricity production still relies on fossil fuels. In 2022 15% came from renewable sources and the government aims at 27% of all produced energy being renewable in 2030 (Buck Consultants International and CE Delft, 2020; Centraal Bureau voor de Statistiek, 2023).

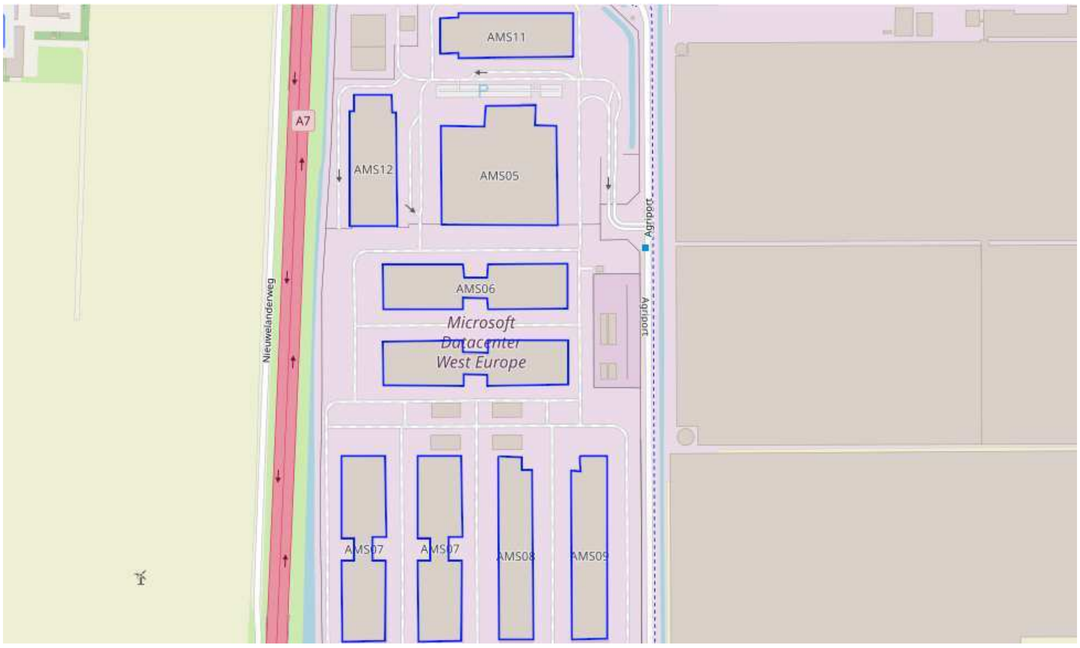
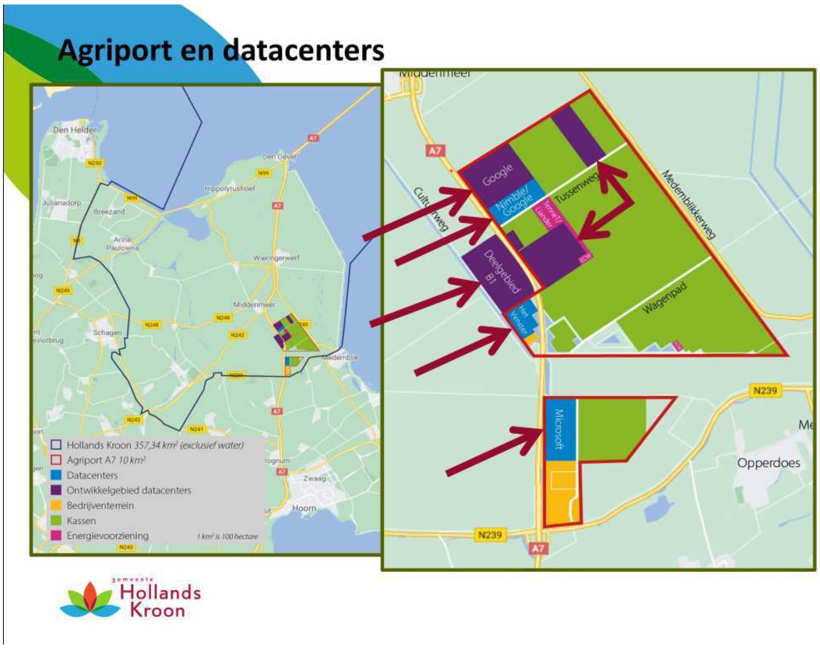

AMS11
A7
AMS12
AMS05
Agriport
AMS06
Microsoft Datacenter West Europe
Nieuwelanderweg
Agriport
AMS07
AMS07
AMS08
AMS09

Figure 5.28: Map of the Microsoft plot at Agriport A7, with data centres AMS05, AMS06, AMS07, AMS08 AMS11 and AMS12 in blue (OpenStreetMap, 2023). Open Database License.

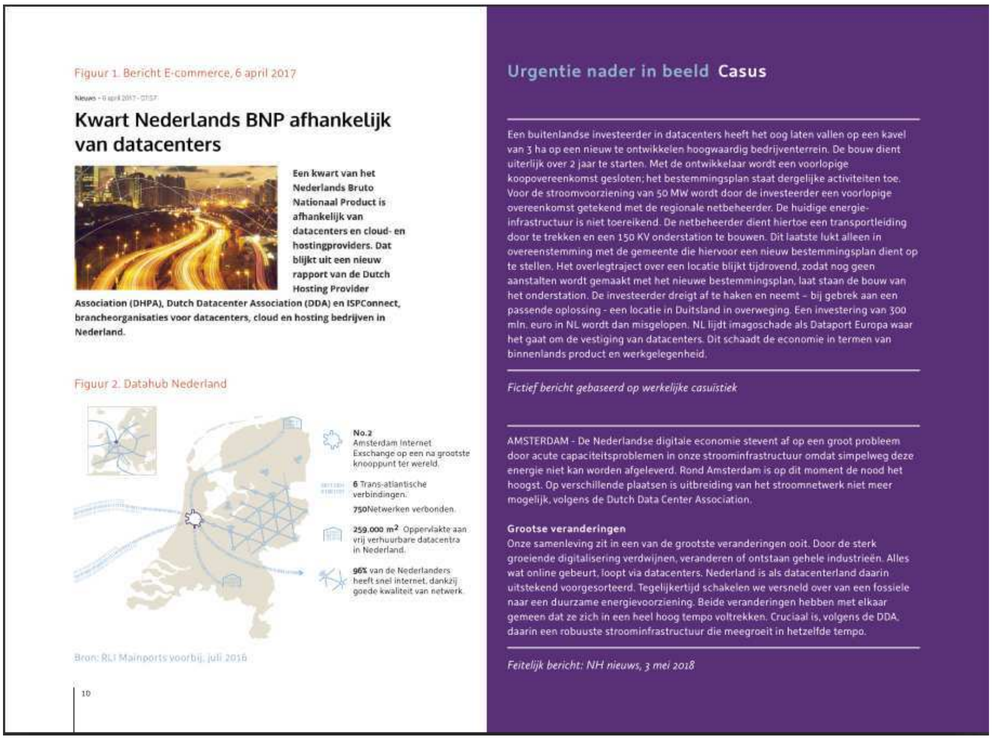

Agriport en datacenters

☐ Hollands Kroon 357,34 km² (exclusief water)
☐ Agriport A7 10 km²
🟦 Datacenters
🟪 Ontwikkelgebied datacenters
🟧 Bedrijventerrein
🟩 Kassen
🟪 Energievoorziening

1 km² is 100 hectare

Den Helder
Den Oever
Hippolytushoef
Julianadorp
Breezand
Anna Paulowna
Wieringerwerf
Middenmeer
Schagen
Medemblik
Opmeer
Zwaag
Hoorn
A7
N239
Google
Nimble/Google
Tussenweg
Deelgebied B1
Het Westen
Medemblikkerweg
Cultuurweg
Wagenpad
Microsoft
Opperdoes
gemeente Hollands Kroon

Figure 5.29: Slide *Agriport and datacenters* from the presentation *Kennissessie Datacenters* by the province of Noord-Holland, the municipality Hollands Kroon and Development Agency Noord-Holland Noord (2022).



Figuur 1. Bericht E-commerce, 6 april 2017

Nieuws - 6 april 2017 - 07:57

Kwart Nederlands BNP afhankelijk van datacenters

Een kwart van het Nederlands Bruto Nationaal Product is afhankelijk van datacenters en cloud- en hostingproviders. Dat blijkt uit een nieuw rapport van de Dutch Hosting Provider Association (DHPA), Dutch Datacenter Association (DDA) en ISPConnect, brancheorganisaties voor datacenters, cloud en hosting bedrijven in Nederland.

Figuur 2. Datahub Nederland

No.2 Amsterdam Internet Exschange op een na grootste knooppunt ter wereld.

6 Trans-atlantische verbindingen.

750 Netwerken verbonden.

259.000 m² Oppervlakte aan vrij verhuurbare datacentra in Nederland.

96% van de Nederlanders heeft snel internet, dankzij goede kwaliteit van netwerk.

Bron: RLI Mainports voorbij, juli 2016

10

Urgentie nader in beeld **Casus**

Een buitenlandse investeerder in datacenters heeft het oog laten vallen op een kavel van 3 ha op een nieuw te ontwikkelen hoogwaardig bedrijventerrein. De bouw dient uiterlijk over 2 jaar te starten. Met de ontwikkelaar wordt een voorlopige koopovereenkomst gesloten; het bestemmingsplan staat dergelijke activiteiten toe. Voor de stroomvoorziening van 50 MW wordt door de investeerder een voorlopige overeenkomst getekend met de regionale netbeheerder. De huidige energie-infrastructuur is niet toereikend. De netbeheerder dient hiertoe een transportleiding door te trekken en een 150 KV onderstation te bouwen. Dit laatste lukt alleen in overeenstemming met de gemeente die hiervoor een nieuw bestemmingsplan dient op te stellen. Het overlegtraject over een locatie blijkt tijdrovend, zodat nog geen aanstalten wordt gemaakt met het nieuwe bestemmingsplan, laat staan de bouw van het onderstation. De investeerder dreigt af te haken en neemt – bij gebrek aan een passende oplossing - een locatie in Duitsland in overweging. Een investering van 300 mln. euro in NL wordt dan misgelopen. NL lijdt imagoschade als Dataport Europa waar het gaat om de vestiging van datacenters. Dit schaadt de economie in termen van binnenlands product en werkgelegenheid.

Fictief bericht gebaseerd op werkelijke casuïstiek

AMSTERDAM - De Nederlandse digitale economie stevent af op een groot probleem door acute capaciteitsproblemen in onze stroominfrastructuur omdat simpelweg deze energie niet kan worden afgeleverd. Rond Amsterdam is op dit moment de nood het hoogst. Op verschillende plaatsen is uitbreiding van het stroomnetwerk niet meer mogelijk, volgens de Dutch Data Center Association.

Grootse veranderingen
Onze samenleving zit in een van de grootste veranderingen ooit. Door de sterk groeiende digitalisering verdwijnen, veranderen of ontstaan gehele industrieën. Alles wat online gebeurt, loopt via datacenters. Nederland is als datacenterland daarin uitstekend voorgesorteerd. Tegelijkertijd schakelen we versneld over van een fossiele naar een duurzame energievoorziening. Beide veranderingen hebben met elkaar gemeen dat ze zich in een heel hoog tempo voltrekken. Cruciaal is, volgens de DDA, daarin een robuuste stroominfrastructuur die meegroeit in hetzelfde tempo.

Feitelijk bericht: NH nieuws, 3 mei 2018

Figure 5.30: Page 10 from the report *Ruimtelijke Strategie Datacenters* issued by the Ministery of the Interior and Kingdom relations (Weerwind and Steembakkers, 2019).

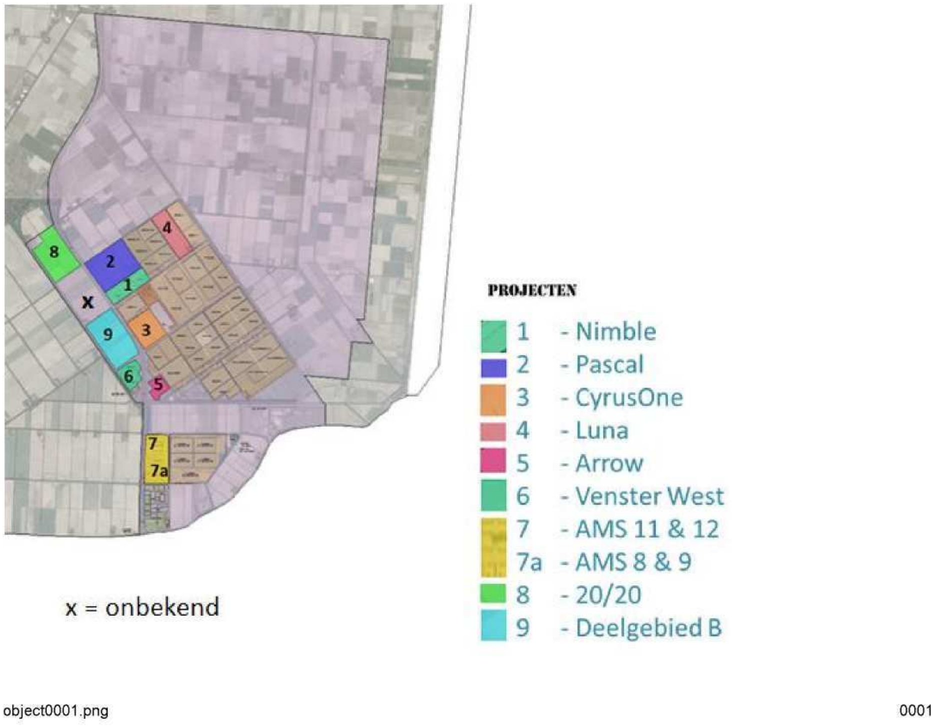
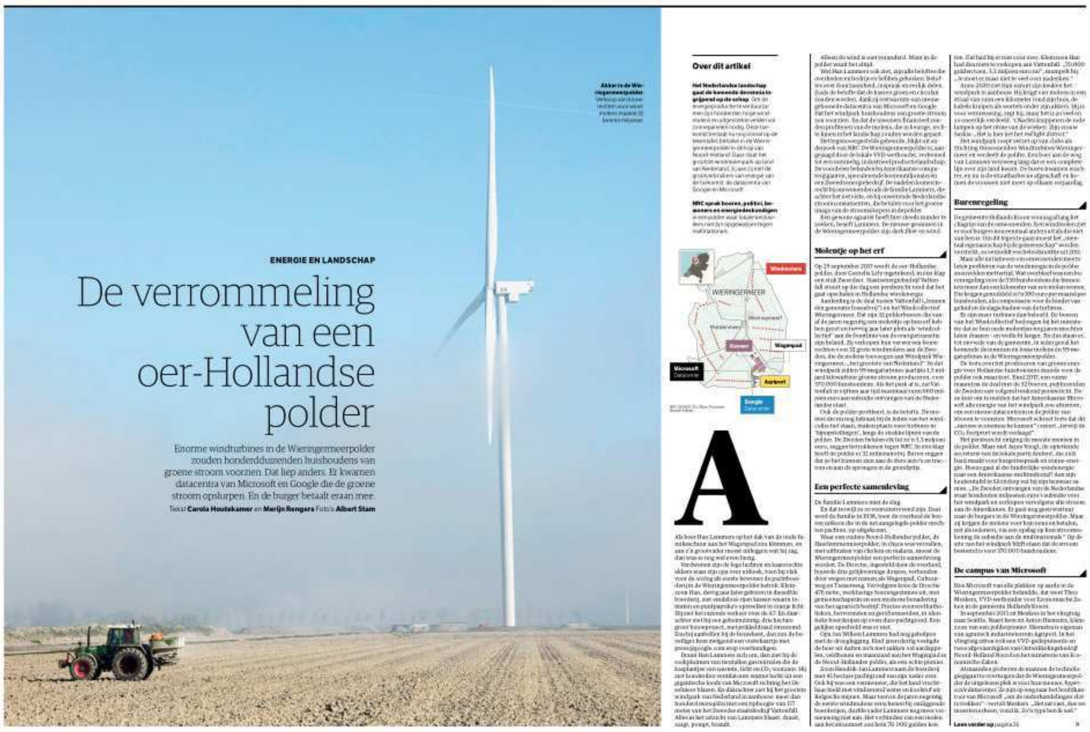


Figure 5.31: Map of existing and running initiatives for data centres at Agriport A7 in Middenmeer (Gemeente Hollands Kroon, 2020a). Public domain.



ENERGIE EN LANDSCHAP

De verrommeling van een oer-Hollandse polder

Enorme windturbines in de Wieringermeerpolder zouden honderdduizenden huishoudens van groene stroom voorzien. Dat liep anders. Er kwamen datacentra van Microsoft en Google die de groene stroom opslurpen. En de burger betaalt eraan mee.

Tekst **Carola Houtekamer** en **Merijn Rengers** Foto's **Albert Stam**

Over dit artikel

Molentje op het erf

Een perfecte samenleving

Burenregeling

De campus van Microsoft

Figure 5.32: The article *The Cluttering of a Typical Dutch Polder* that triggered a lot of public debate, written by Carola Houtekamer and Merijn Rengers, published by the NRC (2020).

In June 2020 the NRC publishes an article outlining how citizens inadvertently sponsor the green image of tech giants (Houtekamer and Rengers, 2020). Small consumers of energy, such as citizens and small companies, pay a Surcharge Sustainable Energy on top of their energy bill, which the state invests in renewable energy projects. Large consumers are mostly exempt from this surcharge and therefore do not participate in the costs.[10] Vattenfall collects 660 million euro in subsidies from the Dutch government for its windpark.

npo
HOF BAR
THEO MESKERS
VVD WETHOUDER ECONOMISCHE ZAKEN GEMEENTE HOLLANDS KROON

Figure 5.33: Still image from episode *Subsidiegesjoemel en verbroken beloftes in de Wieringermeerpolder* of TV show *De Hofbar* by Rutger Castricum, season 03, episode 20 (Castricum, 2020b).

That same month, more media attention. TV show de Hofbar dedicates an episode to data centers in Hollands Kroon. Theo Meskers is interviewed. Minister Eric Wiebes claims the Ministry of Economic Affairs has had no say in the arrival of the data centers, even though it started lobbying Microsoft 11 years ago (Castricum, 2020b).[11] In Septem-

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[10] The *Opslag Duurzame Energie* disappeared in 2023 and became part of the general energy tax (sectoroverstijgende energiebelasting), which is degressive, meaning the more you use the less you pay. This does not only give a perverse incentive to energy intensive industries, it also means they still do not participate in the costs of renewable energy projects. For more information on the ways the Dutch government indirectly subsidises energy intensive industries and fossil fuel with 37,5 billion euro, see the report *Rechtvaardig afbouwen van fossiele subsidies* (Schellekens *et al.*, 2023).

[11] During the episode, Jack van Kranenburg from Agriport A7 reveals that on sunny or windy days, there is a surplus of renewable energy, which needs to be 'leaked' to not overpower the network. Greenhouse owners receive money through a negative energy price, to turn on their lamps during the day. Theo Meskers confirms this (Castricum, 2020b).

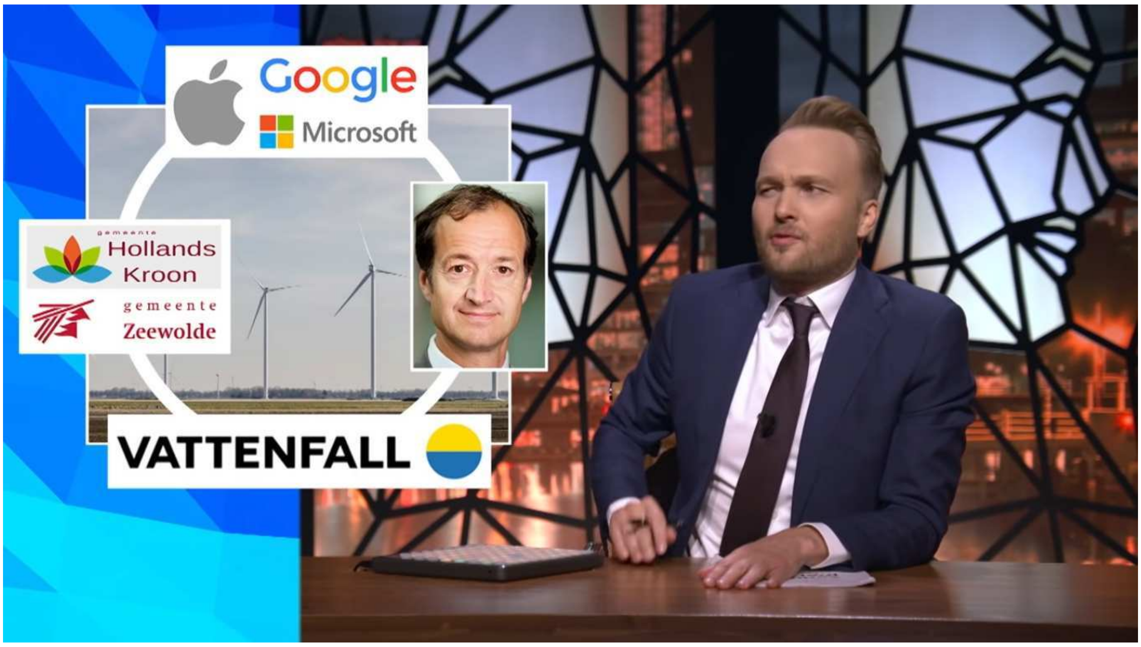

Figure 5.34: Still image from episode *Nederland als harde schijf* of TV show *Zondag met Lubach* by Arjen Lubach, season 12, episode 4 (Lubach, 2020).

ber 2020 Berenschot publishes a commissioned report stating the use of residual heat is financially not feasible in Hollands Kroon.[12] The report also points out that the Dutch government provides several perverse incentives to large consumers of electricity, next to the lower energy tax, the general electricity law from 1998 gives large consumers a discount of up to 90% on their electricity transport costs (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2022).

In September the largest wind park in the Netherlands officially opens in the Wieringermeer, generating electricity equal to the use of 370.000 households. In October the House of Representatives accepts a resolution by Sandra Beckerman (SP) and Agnes Mulder (CDA), asking for independent research on the electricity use of existing and planned data centers. That same month VVD council member Lars Ruiter publishes an opinion piece in the regional newspaper Noord-hollands Dagblad, in which he is critical of the way the arrival of the data centers in Hollands Kroon have been handled (Ruiter, 2020). When I interview him, he tells me he is subsequently requested to leave the VVD (Ruiter, 2023). He joins local party Onafhankelijk Hollands Kroon (Independent Hollands

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[12] Later, in April 2022, during the 'knowledge meeting' at Hollands Kroon, both Google and Microsoft representatives publicly state that the use of residual heat was simply not possible because the heat generated by modern servers is not sufficient and it would require more energy to boost it, making it unsustainable (NHNEXT, 2022).

Kroon).

Even more negative media. The satirical show *Zondag met Lubach* repeats the points made by Houtekamer and Rengers about Dutch taxpayers money indirectly sponsoring the green image of tech giants through government subsidies and tax discounts (Lubach, 2020). Despite all the negative publicity, a new zoning plan is submitted, to allow Agriport and Microsoft to expand east of the A7. That month Lars Ruiter notices Microsoft is already paving a parking lot on the east-side of the A7, even though the new zoning plan has not yet been approved (Rengers and Houtekamer, 2020).

In December, Google's data center is operational (Google, 2020b), and journalist Rutger Castricum (2020a) visits the town hall. The council's data center-related Whatsapp group is alarmed (Gemeente Hollands Kroon, 2021a).

> "[Anonymous]: [Rutger] walks in and around mfa. the ladies at the service desk have asked him to leave the building. He walks in and out. That is allowed. It is a public building, our part. he wants to talk to the alderman. Theo M called him and got rid of him. I told the service desk ladies that Rutger can call me with questions. Stay calm and don't make too much of a fuss.[...]"
>
> "[Anonymous]: The storm will calm now."
>
> "[Theo Groot]: Do not discuss the environmental permit right now!"
>
> "[Anonymous]: I know. I won't."

2021

In January 2021 the environmental permit for the plot at 'Het Venster' is issued. In March the province objects to the municipality issuing the permit. On the plots of Microsoft and Google combined, some 2 million litres of diesel is stored (Veiligheidsregio Noord-Holland Noord, 2021).[13] Microsoft and Google are indeed on the list of the Dutch Emission Authority, next to other large emitters like Tata Steel and Shell, meaning the province is responsible for the permit (Dutch Emissions Authority, 2021, 2022).[14]

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[13] In 2021 1.373.700 litres diesel is stored by Microsoft and 570.000 litres at Google (Vuijk, 2021).

In March more negative media attention. The NOS and de Telegraaf report on the use of drinking water in the cooling systems of Hollands Kroon's data centers, 84 million liters per year, warning of potential drinking water shortages and waste water ending up in canals (NOS, 2021). That same month the first independent inquiry commissioned by the Ministry of Economic Affairs and Climate into data centers shows that only 27% of Dutch data center capacity is used by companies located in the Netherlands. The Dutch digitisation strategy does not run any risk if future hyperscale data centers are blocked (Buck Consultants International, 2021).

November 2021 Extinction Rebellion Almere creates national uproar about a Meta hyperscaler coming to Zeewolde. An anonymous person from Middenmeer invites XR Almere to do the same for Hollands Kroon. They were willing to try, and dropped by to hang banners on the city hall but it was being renovated. They hung them on the offices in Anna Paulowna but this didn't generate much attention (Ruiter, 2023).[15]

2022

February 2022 all the negative media attention and questions in the House of Representatives finally leads the government to decide on a 9 month moratorium on the construction of new large data centers. The decision doesn't apply to Hollands Kroon and Eemshaven. In March the municipal elections are held. A new, more progressive coalition is formed and Theo Groot and Theo Meskers retire from local politics.

In April 2022 an Information meeting about data centers is held (Provincie Noord-Holland, Ontwikkelingsbedrijf Noord-Holland Noord and Gemeente Hollands Kroon, 2022). The evening starts with the news that area B1's zoning plan now allows for data centers to be build but they need to blend in with the landscape. A binding image quality plan has been made and a 'target image' is shared (figure 5.38).

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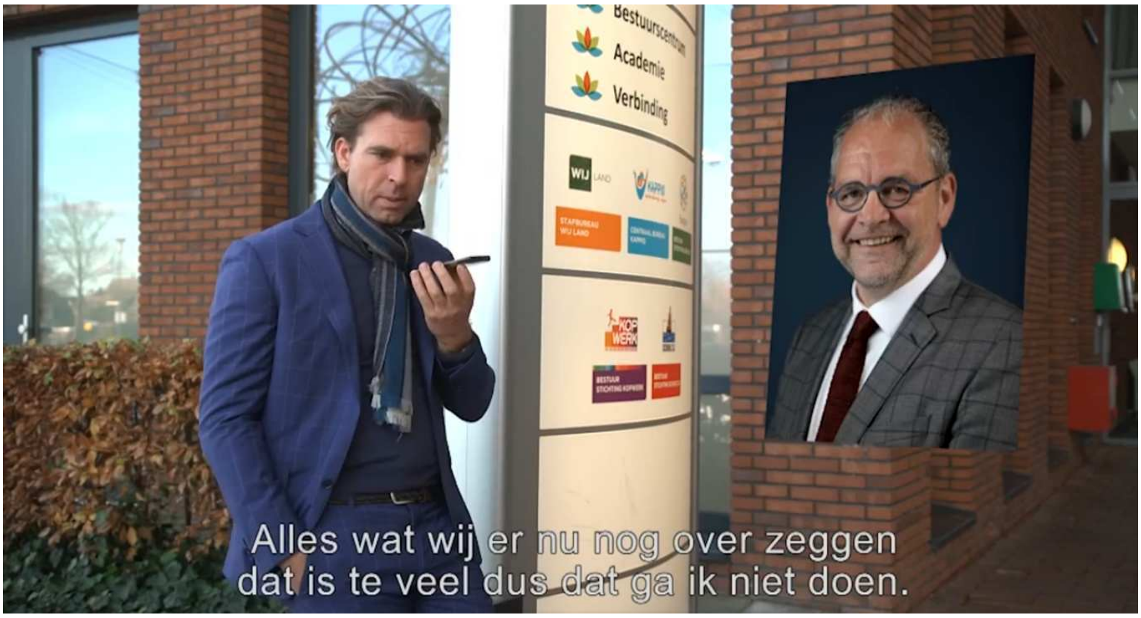
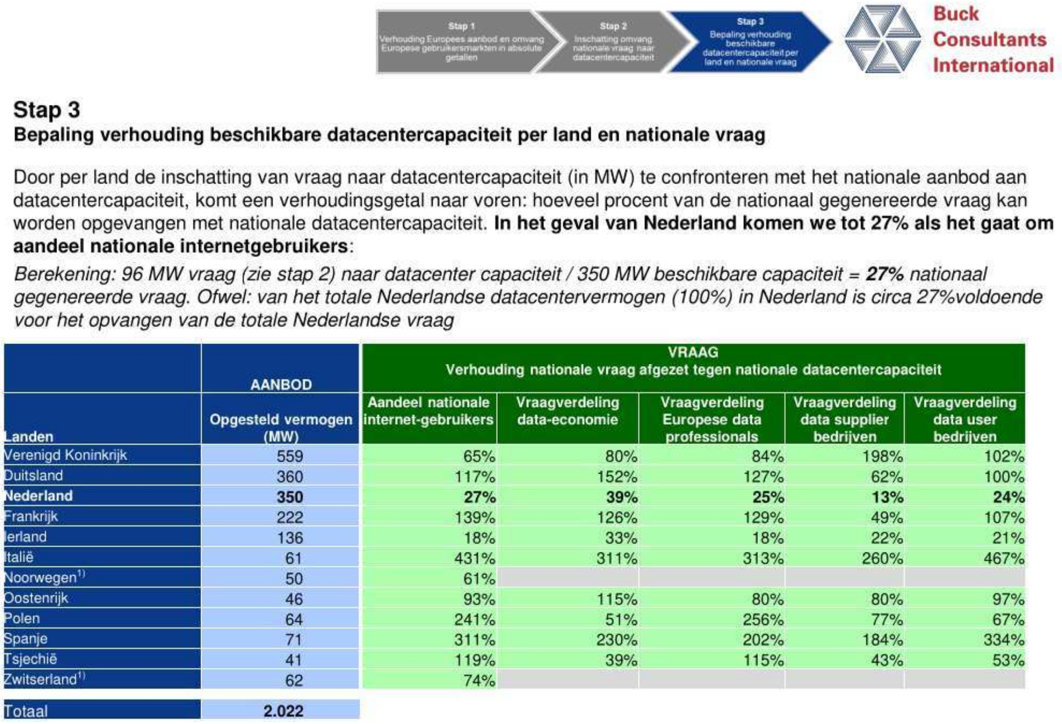
[14] Microsoft is listed in the 2013-2020 file, but is not listed in the years 2021 and 2022, even though it is still expanding and is still making use of diesel generators. Google is only listed in the 2021-2022 file since its data centre in Hollands Kroon became operational in December 2020.

[15] In the interview from April 2023 Lars Ruiter mentions that the data center issue is not discussed much in other towns in the municipality, only in Middenmeer (Ruiter, 2023).



Alles wat wij er nu nog over zeggen
dat is te veel dus dat ga ik niet doen.

Figure 5.35: Still image from episode *Despite objections, more data centers in Hollands Kroon* of TV show *De Hofbar* by Rutger Castricum, season 4, episode 14 (Castricum, 2020a). The subtitles read what Meskers, who is hiding inside the building, replies to Castricum asking for comments: "Anything we will say about this now is too much so I will not do that."



Stap 1
Verhouding Europees aanbod en omvang Europese gebruikersmarkten in absolute getallen

Stap 2
Inschatting omvang nationale vraag naar datacentercapaciteit

Stap 3
Bepaling verhouding beschikbare datacentercapaciteit per land en nationale vraag

Buck
Consultants
International

Stap 3
Bepaling verhouding beschikbare datacentercapaciteit per land en nationale vraag

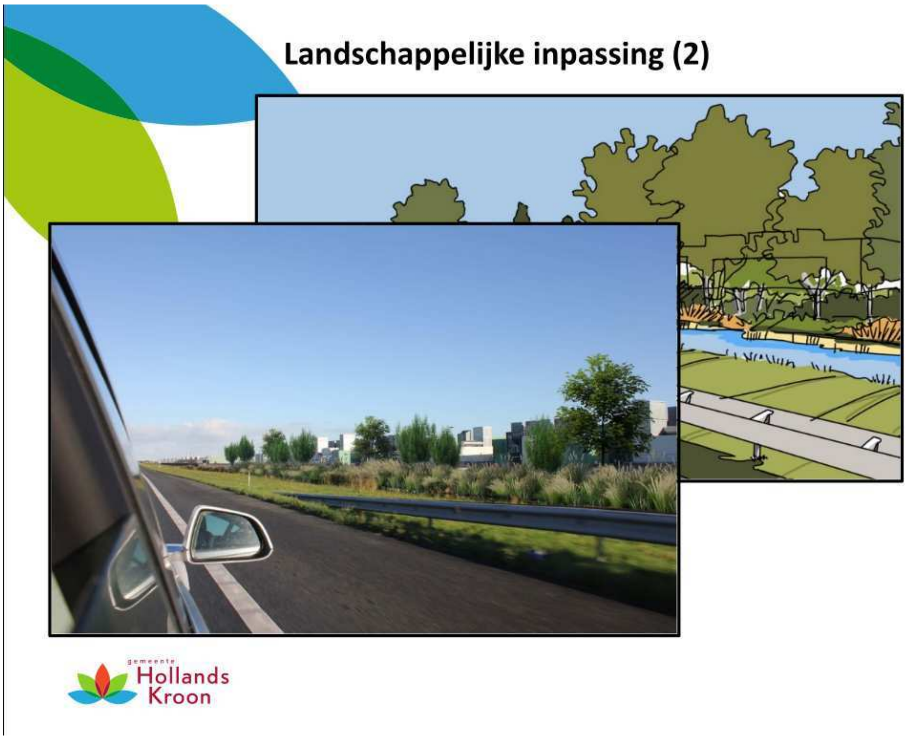
Door per land de inschatting van vraag naar datacentercapaciteit (in MW) te confronteren met het nationale aanbod aan datacentercapaciteit, komt een verhoudingsgetal naar voren: hoeveel procent van de nationaal gegenereerde vraag kan worden opgevangen met nationale datacentercapaciteit. **In het geval van Nederland komen we tot 27% als het gaat om aandeel nationale internetgebruikers**:

Berekening: 96 MW vraag (zie stap 2) naar datacenter capaciteit / 350 MW beschikbare capaciteit = ***27%*** *nationaal gegenereerde vraag. Ofwel: van het totale Nederlandse datacentervermogen (100%) in Nederland is circa 27%voldoende voor het opvangen van de totale Nederlandse vraag*

	AANBOD	VRAAG Verhouding nationale vraag afgezet tegen nationale datacentercapaciteit				
Landen	Opgesteld vermogen (MW)	Aandeel nationale internet-gebruikers	Vraagverdeling data-economie	Vraagverdeling Europese data professionals	Vraagverdeling data supplier bedrijven	Vraagverdeling data user bedrijven
Verenigd Koninkrijk	559	65%	80%	84%	198%	102%
Duitsland	360	117%	152%	127%	62%	100%
Nederland	**350**	**27%**	**39%**	**25%**	**13%**	**24%**
Frankrijk	222	139%	126%	129%	49%	107%
Ierland	136	18%	33%	18%	22%	21%
Italië	61	431%	311%	313%	260%	467%
Noorwegen[1)]	50	61%				
Oostenrijk	46	93%	115%	80%	80%	97%
Polen	64	241%	51%	256%	77%	67%
Spanje	71	311%	230%	202%	184%	334%
Tsjechië	41	119%	39%	115%	43%	53%
Zwitserland[1)]	62	74%				
Totaal	**2.022**					

Figure 5.36: Page 44 of the report *Exploration of the relation between accommodation data centers and digitalisation opportunities* (Buck Consultants International, 2021).

Figure 5.37: Still from the video recording of *Informatiebijeenkomst data centers Hollands Kroon* (NHNEXT, 2022).


Landschappelijke inpassing (2)

gemeente Hollands Kroon

Figure 5.38: Page 8 from the presentation *Informatiebijeenkomst datacenters Hollands Kroon* showing the landscape integration vision for future data centres (Provincie Noord-Holland, Ontwikkelingsbedrijf Noord-Holland Noord and Gemeente Hollands Kroon, 2022).

Ilse Zaal, D66 deputy of the province of Noord-Holland, repeats there will be sustainability requirements such as, there it is again, delivering residual heat to greenhouses. Both Google and Microsoft representatives however, say the temperature of the air is simply not high enough. Making the residual heat hotter in a sustainable way is not possible. One day before the meeting Microsoft publishes the blogpost "Blending datacenters into Wieringermeer nature with biomimicry" (Microsoft, 2022a).

> "Using the tools of biomimicry, a practice that learns from and mimics the strategies found in nature to solve human design challenges, the team started by learning how resilient landscapes function in the province of Noord-Holland." (Microsoft, 2022a)

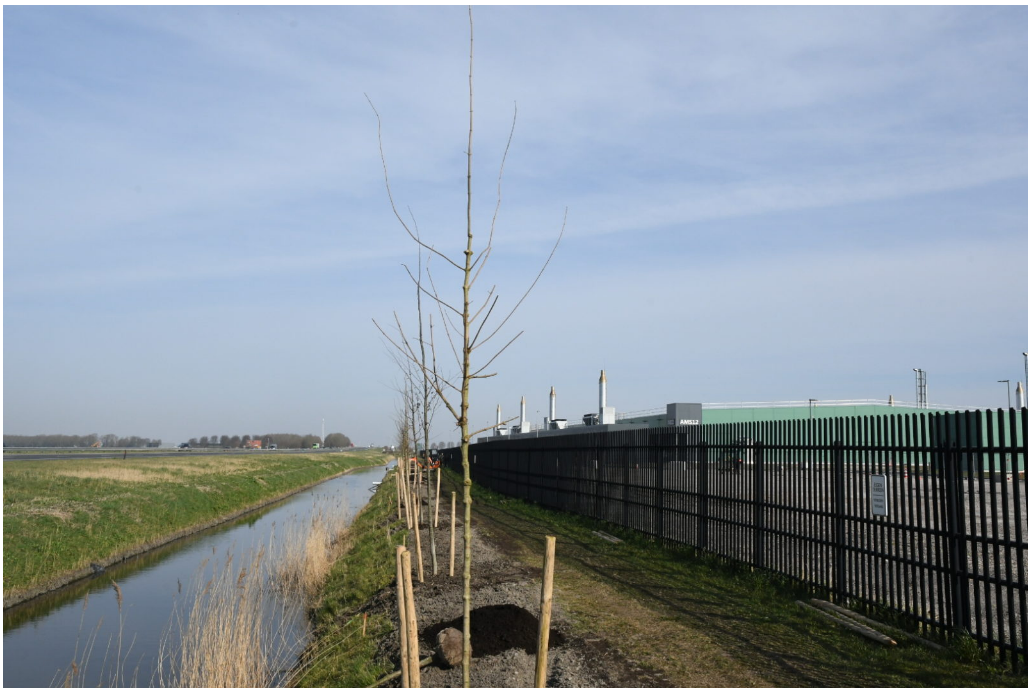


Figure 5.39: Photo featured on the *Microsoft in Your Community* blog, titled *Tree Line*, showing Microsoft's interpretation of biomimicry as applied to the local data centres (Microsoft, 2022b).

"We expect the native plants we chose will mirror a healthy, resilient ecosystem and support biodiversity, improve storm water control, and prevent erosion while reflecting the natural beauty of Noord-Holland," said Kaitlin Chuzi, Director of Biomimicry, Microsoft (2022a).

2023

In April 2023, in response to the public debate about data centers, the municipal executive of Hollands Kroon stops plans for new data centers at locations ‘Luna’ and ‘Cyrus One’, number 3 and 4 in figure 5.31 (Gemeente Hollands Kroon, 2023). In July 2023 the EU legislation *The European Energy Efficiency Directive* (EED) on energy efficiency and amending regulation will require data centers to report their 2023 energy and water use by March 2024 (European Commission, 2023). The law came into force in September 2023.

To be continued...

In May 2024 there should have been actual data available, rather than estimations. The deadline has been delayed to the 15th of September and still, at the time of writing (December 2024) there is only very incomplete data accessible. Google and Microsoft haven’t published the required reports on their data centers in Hollands Kroon.[16]

The arrival of Agriport did not instantly turn the Wieringermeer into the feared hotbed of insurgent activity, although the protests and activism of locals did, after 18 years of agri-industrial expansion, block further growth for now. For 13 years, the magic words ‘business climate’, and ‘residual heat’ were enough to convince national and local governments. No supporting evidence regarding the effects on employment, connectivity, digitisation, emission targets, landscape, quality of life of locals, energy-, land-, water- and diesel use was requested.

The delegation flying to Seattle in 2013 could have stayed home. The deal was so sweet, Microsoft pounced at the opportunity, yet under one pivotal condition: absolute secrecy. A wise demand, because as soon as journalists started reporting on the water-, land-, electricity- and diesel use around 2020, aided by Extinction Rebellion’s and local activism, public support crumbled and a national moratorium on the construction of new data centers was issued.[17]

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[16] I emailed the RVO asking why the reports of Google and Microsoft were missing, and was answered (translated from Dutch): “The reason is that we have not received the indicated information. In the coming years we will sharpen the enforcement. The next deadline is May 15 2025. We hope to receive more information then.” (Blacquière, 2024, personal communication).

A Tale of Two Data Centres is not just a melancholic reconstruction of a process of ruin, it is a hopeful story too; a tale of local resistance, investigative journalism and activism having a big impact on public opinion, which in turn triggered political change on national and local levels. In the end, Middenmeer did become a ‘hotbed of insurgent activity’ that drew in reporters to investigate and file Freedom of Information Act requests, revealing the undemocratic process and careless handing out of fertile soil and scarce renewable energy to multinationals serving no interests but those of their shareholders. The secrecy within the council and municipal executive of Hollands Kroon, obeying the request for silence by Google and Microsoft, made sure this upheaval was delayed by about a decade.

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[17] Sadly Hollands Kroon and Eemshaven were not included.

Tangible Cloud Oracle

The *Tangible Cloud Oracle* is a modified publication of the famous Smith-Waite Tarot cards, designed by Pamela 'Pixie' Colman Smith (1871–1951).[1]

The cards are based on designs and ideas from the 2022 *Tangible Cloud* and *Art Meets Radical Openness* workshops I led, in which participants created a set of cards with executable words that can help think through more sustainable artistic practices making use of tech; from hardware to software, from websites to types of services that can be run on a server. The deck brings together counter-narratives about technology in solidarity with human and non-human others.[2]

The cards are inspired by pattern languages in the way these can form hypertexts, a network of linked ideas and practices that can inform and orient action.[3] The oracle is a type of pattern language in a highly compressed form: a set of executable words that express practices that challenge the tech industry's master narrative of progress and innovation, which results in extraction, pollution and depletion.[4] It is a materialist approach to divination, not abstracted from, but entirely embedded in material environments and ecologies; rather than trying to capture the future through quantification and abstraction of repeating patterns, performing a repetition of the present; it attempts to actively and collectively make space for reflection on the present in order to open paths to possible futures.[5]

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[1] This is the original text as published in the booklet accompanying the riso-printed card deck. For the purpose of this portfolio, I added a few footnotes providing additional contextual information.

[2] The workshops *A Glossary - mapping the territory* and *Executable Words - a deck of (magic) pattern cards* at *Tangible Cloud*, Green Fabric, Brussels, 18-21 May 2022 and workshop *chmod 777: writing an executable glossary of (perma)computational practices*, 16 June 2022, at *Art Meets Radical Openness*, Linz.

[3] A pattern language is a collection of words, each related to a reoccurring problem in a specific field, and suggests the core to a solution and links to related words. The concept was introduced in the book *A Pattern Language: Towns, Buildings, Construction* in 1977 (Alexander, Ishikawa and Silverstein, 2010).

[4] In these workshops I invited the participants to explore the potentials of cross overs between the 'executable' nature of pattern languages and the contestation of ideologically loaded words of Williams' *Keywords* as intervention in artistic practice (Williams, 1976; Alexander, Ishikawa and Silverstein, 2010).

[5] This approach to divination is inspired by *The Politics of Divination* by Joshua Ramey (2016).

History

The Smith-Waite tarot was published in 1909 and is now in the public domain, resulting in many different derivative works. Colman-Smith and Waite adjusted older tarot designs to match the ideas of the occult *Hermetic Order of the Golden Dawn*, of which they were both members. Colman-Smith was an illustrator, artist, writer and publisher. She ran the *Green Sheaf Press*, an indie-publisher focused on women writers. Her designs for the tarot were inspired by the *Tarot de Marseilles*, which was popular in France in the seventeenth and eighteenth century. This tarot was used for playing games at first, and since the late eighteenth century for divination. Francophone occultists falsely claimed the cards had their origins in ancient Egypt, the Kaballah and the I Ching. One of them, Eliphas Levi, believed the cards could solve all problems through their thought evoking and infinite possible combinations.

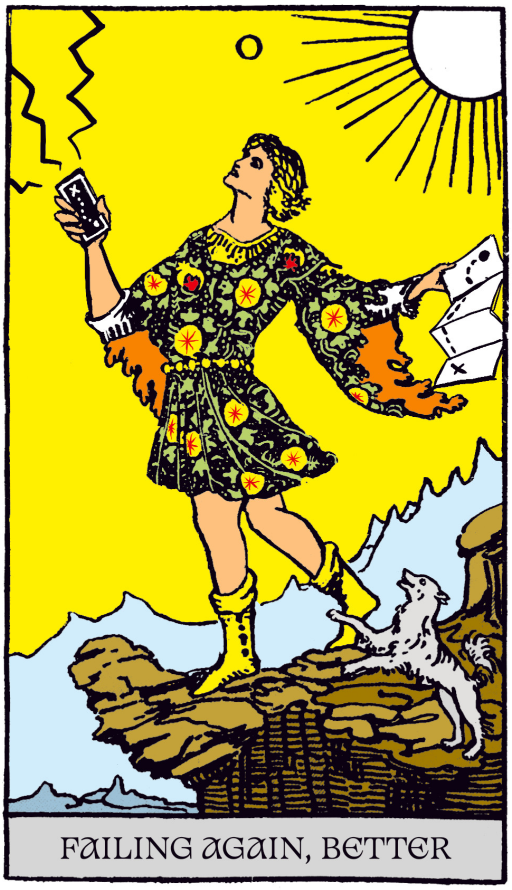
The *Tarot de Marseille* was based on early fifteenth century Italian playing cards, which were called trionfi, later known as tarocchi, with the trump cards having simple allegorical meanings stemming from Italian court life. The cards depict medieval Italian society and were meant for playing games but also to teach virtues and warn, in true medieval style, of death and god's judgement. Playing cards arrived in Italy from Mamluk Egypt in the 1370s after having spread throughout Asia from China, where they appeared in the ninth century as a result of woodblock printing technology.

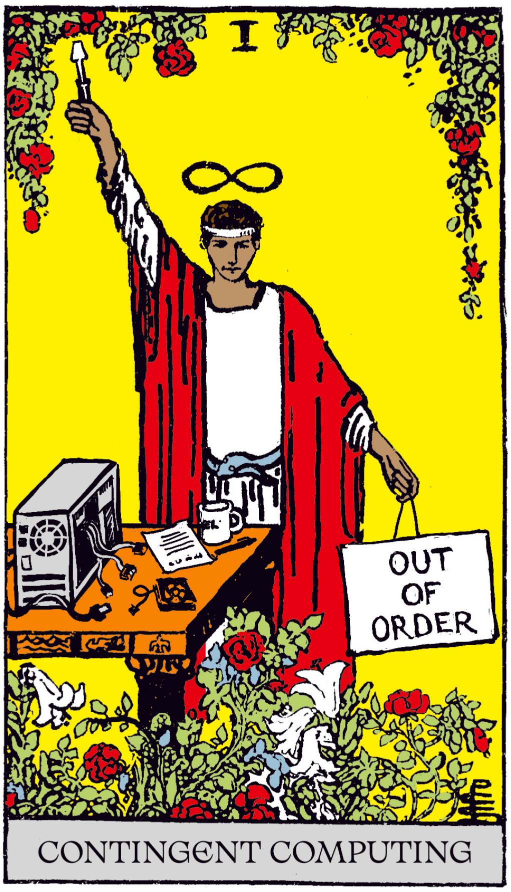
The *Tangible Cloud Oracle* is aware of its long and winding history, its changing symbolism and function. This oracle uses allegorical imagery from late capitalist society and the counter-narratives shared among the people who gathered in Brussels and Linz in the spring of 2022.

How to use the oracle

Oracle cards can be used freestyle, unlike tarot cards, which traditionally have more complex methods of reading. The easiest way to use an oracle deck is to go somewhere quiet, make yourself comfortable, and formulate a question or think of a project that you'd like to develop. Concentrate on the question while shuffling the cards. Place the cards face down in a fan or overlapping line so you can see each card's back. Draw one card. Read the card's meaning or interpret it in your own way, in relation to your question. Another method is to do the same but draw three cards instead and think about how each card could relate to and inform the others and your initial question.

The cards

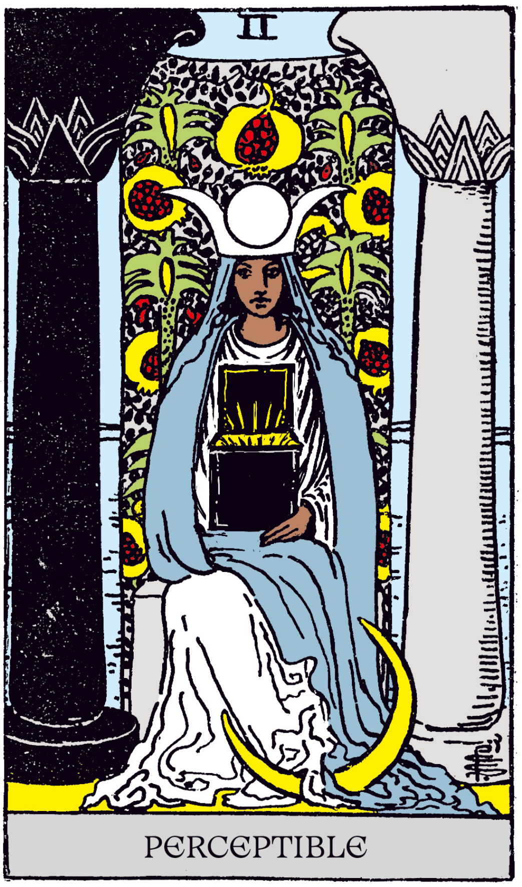


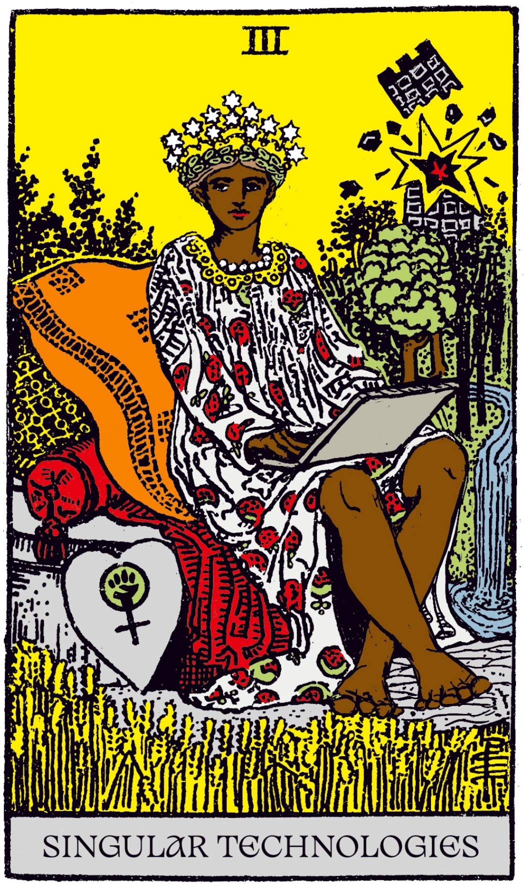


0. Failing Again, Better

An adventurous person blindly follows their phone's navigation and is about to walk into a ravine. There is hope though: an animal friend warns them and with the map in hand, they possess the knowledge and sense(s) to learn and find their way.

If you have the time, failure can be an opportunity to learn more about a process and become closer to it. Sometimes it's a shame when things just work.





I. Contingent Computing

A determined looking person is at a table with an opened computer, some tools, a text and a mug. With a screwdriver in one hand and an ‘out of order’ sign in the other, they channel their energy and creativity into an ongoing cycle of using, breaking and repairing.

A type of computing which riffs off not being reliable. Trying to do tech without the promise or hope of reliability.

II. Perceptible

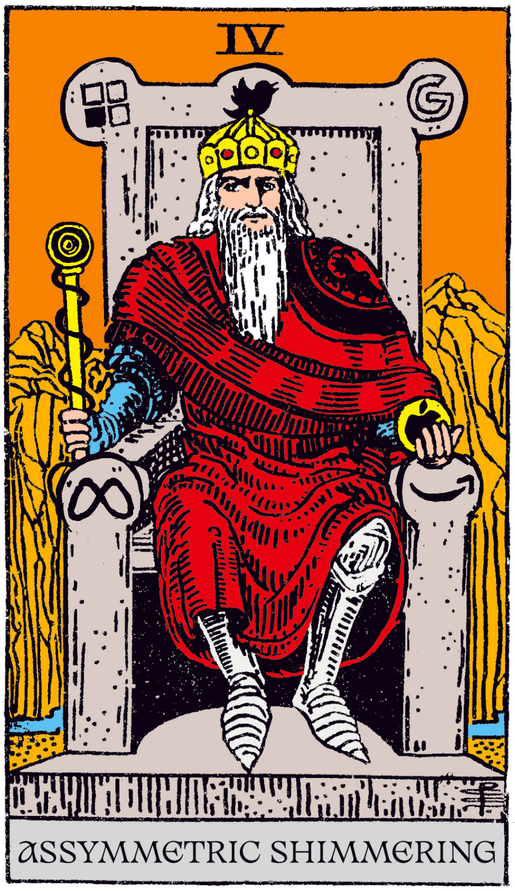
A witch opens a black box. Light escapes and inner workings are revealed.

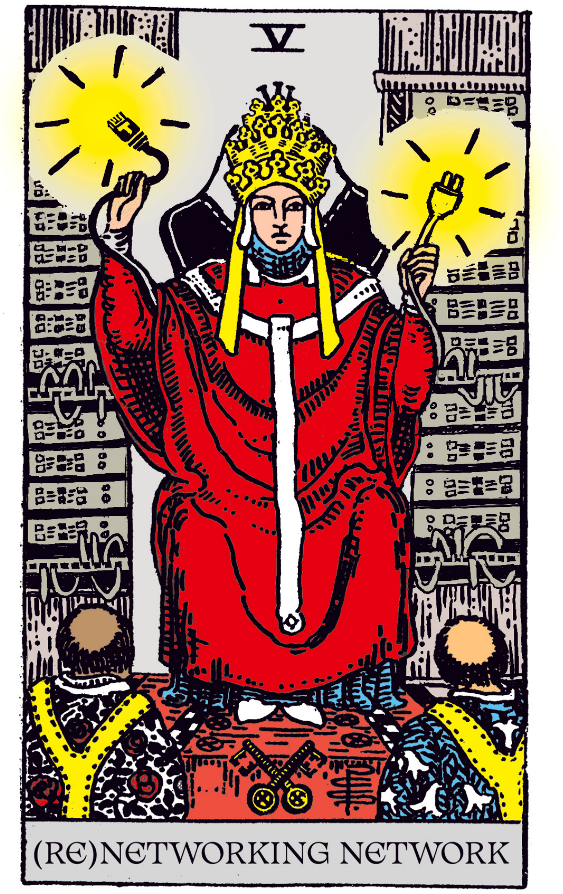
Make the hidden (on purpose or not) and incomprehensible visible. Make techniques and processes accessible to our perception.

III. Singular Technologies

A person in a summer dress casually blows up a tower, symbol of coercive power and oppression, and a dam, a (neo)colonial structure of dispossession and environmental harm. The liberated river runs through a forest towards the person, nourishing the food crops growing at their feet. Intersectional and environmental feminism supports them.

"Technology is not something to be applied to any given context: it can emerge from usage and the encounter of the living and its expression into the world. Because the relation is material both technology producers and tools are affected, and transformed by their interaction." (Petites Singularités)





IV. Asymmetric Shimmering

An old king in full armour sits on a throne with the logos of Big Tech. He is holding a webcam pointed at you.

Where are you within the matrix of power? If exerting power: transparency. If being exerted power upon: opacity. Else if seeking comradeship: iridescence.

V. (Re)networking Network

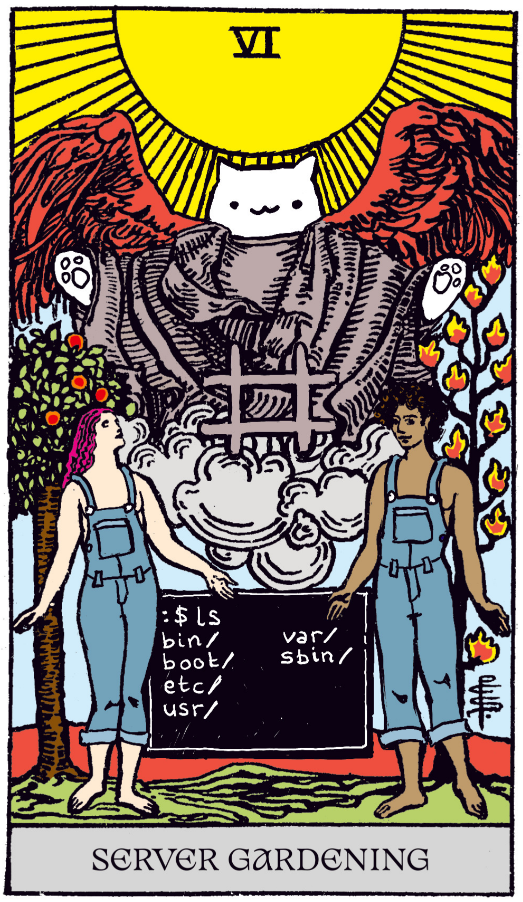
A priest sits in a gamer chair in front of two server racks with an ethernet cable in one hand, and a power plug in the other; holding on to centralised power over the network. Two monks kneel in front of him, begging for access.

Internet can be a decentralised or even distributed network but there are a few actors which produce centralisation through control and possession of infrastructure as well as through corporate capture, locking users in. This card invokes an awareness of the centralised power at different levels of network infrastructure and invites experimentation with its undoing from the edges.

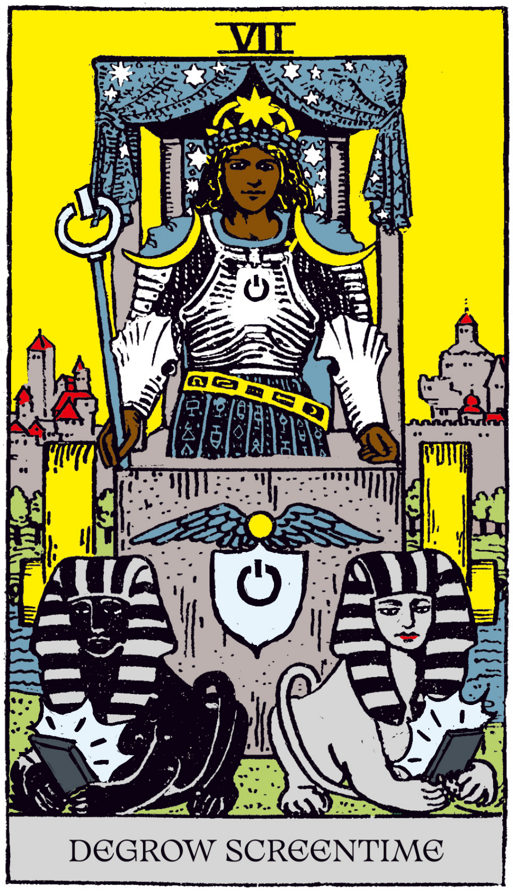
VI. Server Gardening

Two people in dungarees stand in a garden next to a terminal showing a command-line interface. Above them, an angelical Bongo Cat on a cloud grants them root access to the server.

Self-hosting not just as owning data but also as reappropriating a technical know-how.



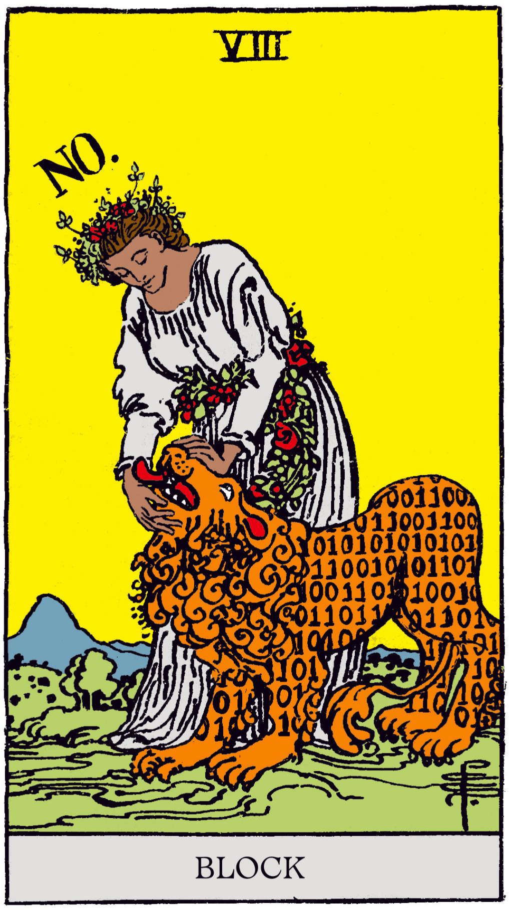
```
:$ ls
bin/      var/
boot/     sbin/
etc/
usr/
```

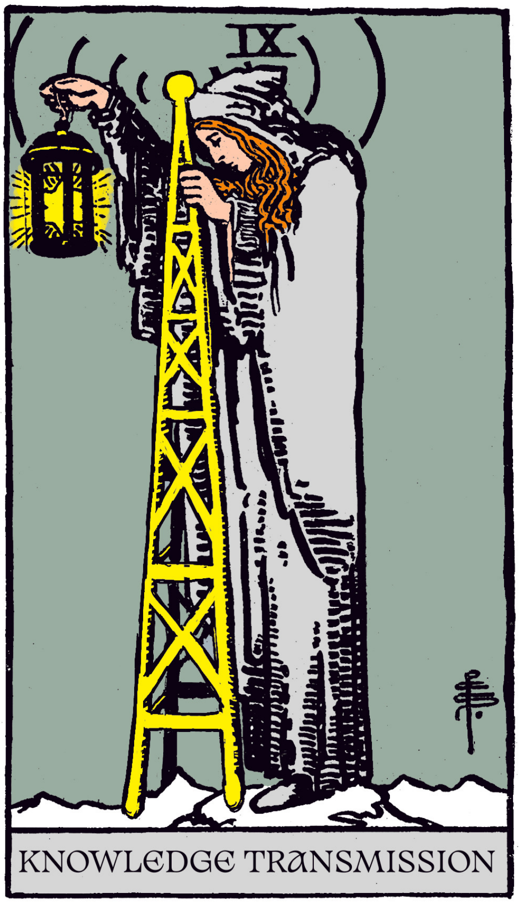


VII. Degrow Screentime

A person on a chariot is holding a staff with a power button. They gaze victoriously into the distance, aware and in control, even without reins to steer. The chariot is not pulled because the two sphinxes that should be pulling are on their phones.

Small interventions that limit the time you look at a screen each day: switching off automatically after 20 minutes, a maximum credit per day, designs that break the spell of the screen, an off button...





VIII. Block

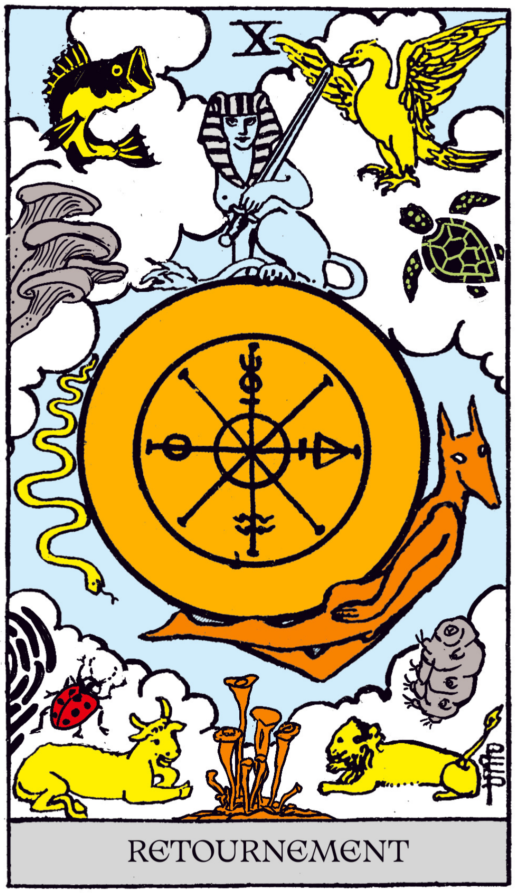
A person is standing over a lion covered in binary data and gently but firmly says: no.

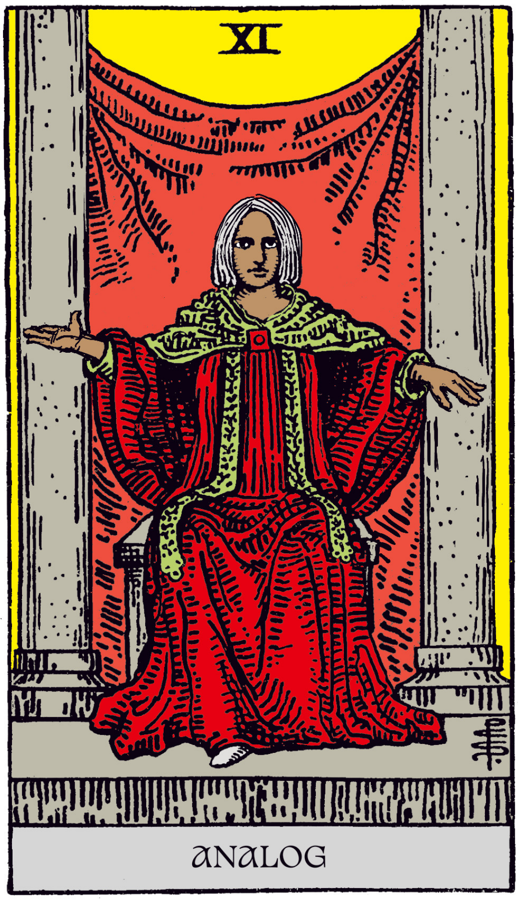
Block attachments, advertisements and tracking to limit surveillance and the automatic transfer of often useless data.

IX. Knowledge Transmission

A seemingly solitary person is standing in the dark, holding a lantern illuminating their path. They are not alone though, they are communicating and exchanging via their trusty old radio tower.

When learning a tool, a craft or a technique, always think about it over 20 years. Will it still exist? Will you be able to bend it to future scenarios and context?





X. Retournement

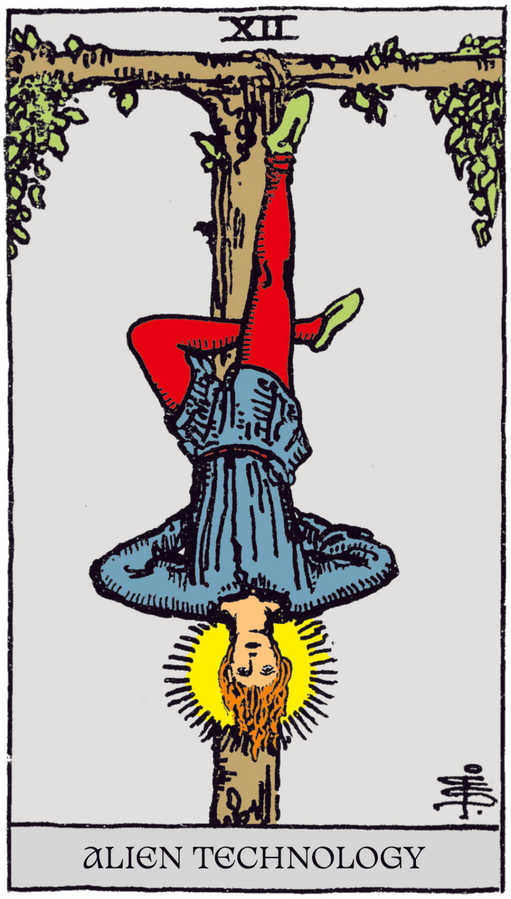
A sphinx, representing wisdom, sits on a wheel carrying the alchemical symbols for mercury, sulphur, water and salt, which represent a process of unfolding change and chance. The Egyptian gods of destruction and death encircle the wheel. The whole scene is surrounded by radically different yet interdependent lifeforms.

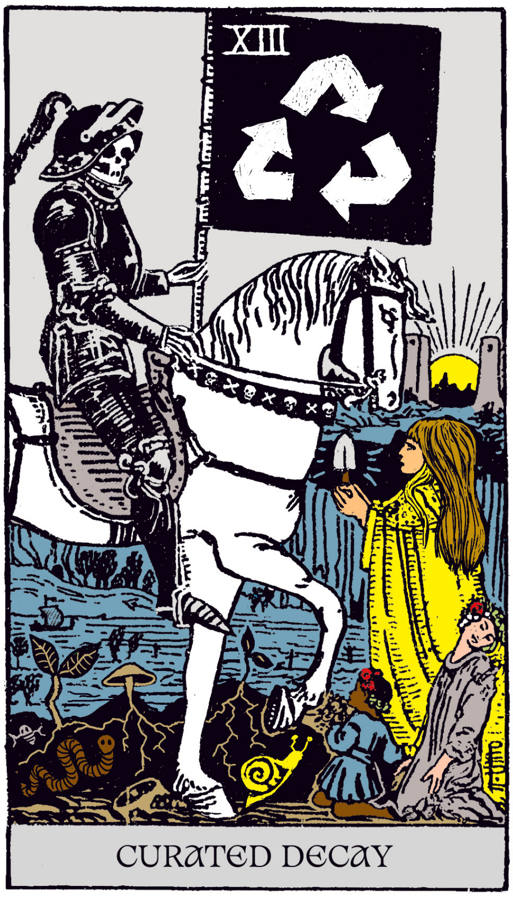
"Given a situation, everything falls into place, it just works. But what if we remove evidence, that which is obvious. Remove the basis for evidence. Dig into the source of the discourse and turn it upside down to help decolonise our own thought." (Petites Singularités)

XI. Analog

A focused person sits and concentrates, carefully weighing what matters and what can be left out of consideration. They find balance.

Could it be analog? Does it need electricity? Does it need to exist at all?





XII. Alien Technology

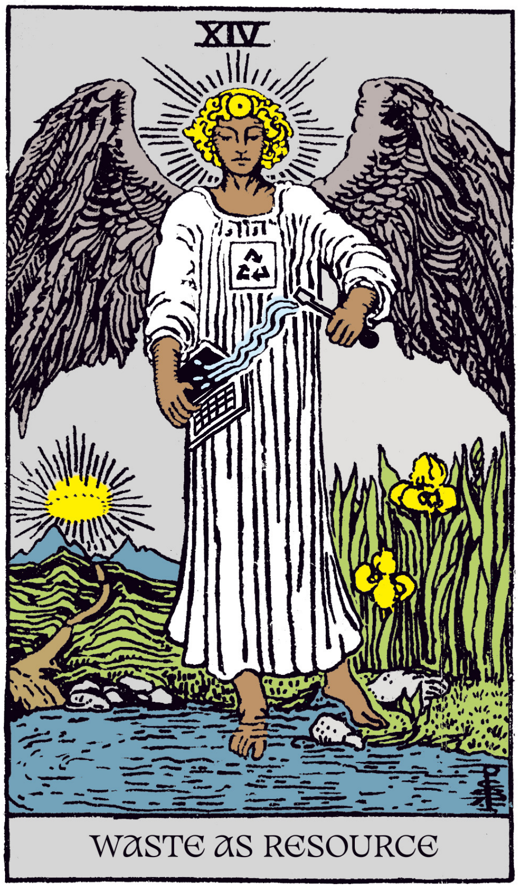
A person hangs upside down, which makes them see everything from a new perspective and enlightens them. What they think of is so different, so alien, it defies depiction.

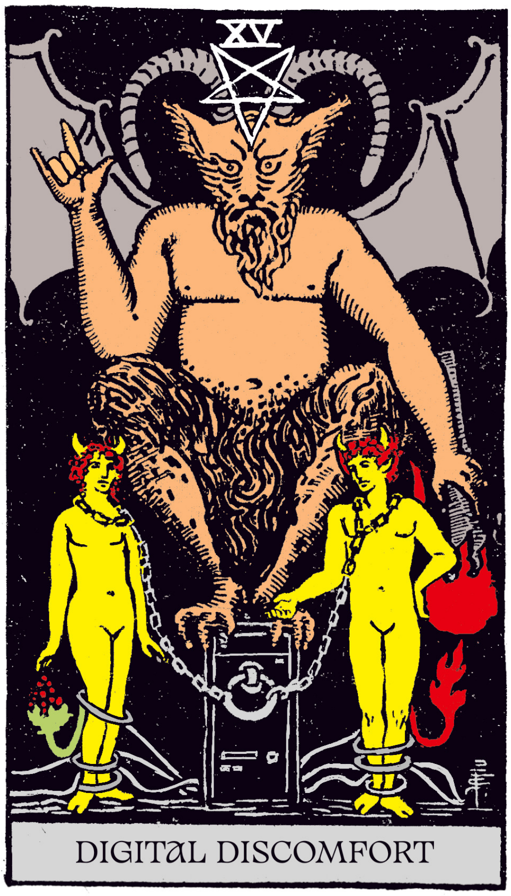
Inventing technological systems or devices that follow a truly alternative path to commonly known paths of innovation.

XIII. Curated Decay

Death rides their horse holding a flag with a recycling icon. A person holding a hand spade and two children stand before death and a compost heap with a snail, a worm, some plants and a mushroom.

When creating something new, consider the way the work will decay and plan for this with consideration of how this end-of-life phase could either enrich or weigh on others, human and non-human, near and far, in terms of labour, energy, waste and pollution.





XIV. Waste as Resource

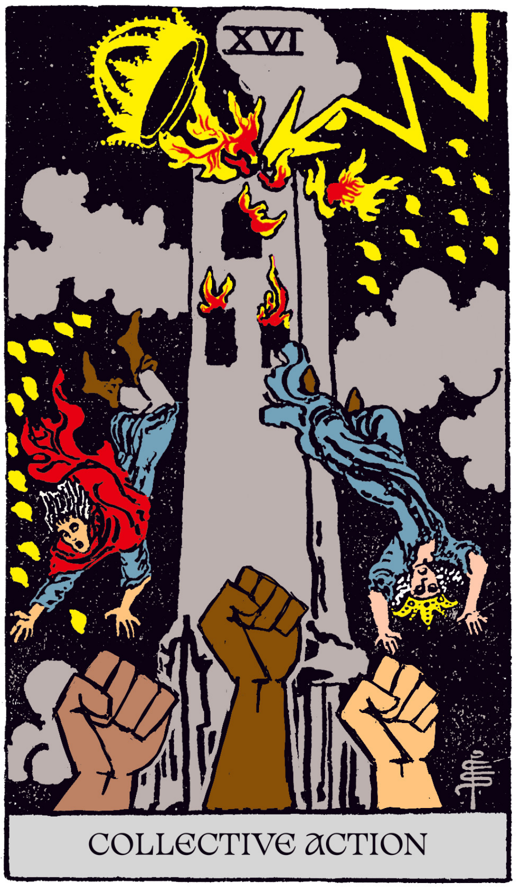
An angelical fixer balances one foot in the water and one foot on land, being both grounded and in a flow. Energy is preserved. They are repairing a broken laptop.

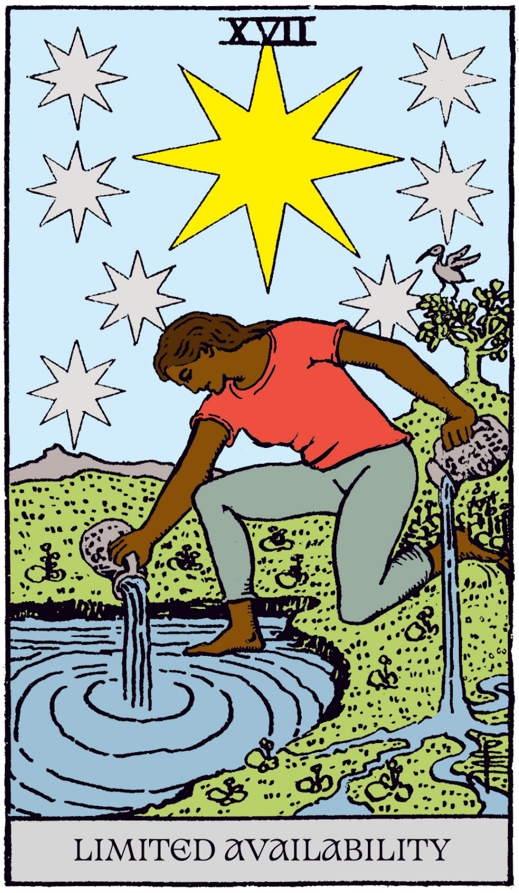
Waste is only wasted if it is discarded. It can be a resource through repair, upcycling, gambiara, resolver and remain a resource through maintenance.

XV. Digital Discomfort

Two people are chained to a computer, on which the devil is seated. Their legs are tied by network and power cables. The devil greets you with a wistful hand gesture, remembering they were once a pagan god of nature, but were transformed by Christianity into a (d)evil symbolising wild nature as subservient to mankind, in need of suppression and control.

Living within the paradoxes of current tech-conditions. Try to stay away from repair or the desire for removing discomfort and find modes of doing discomfort together in solidarity. This description is inspired by the Cell for Digital Discomfort (Cristina Cochior, Jara Rocha and Karl Moubarak).





XVI. Collective Action

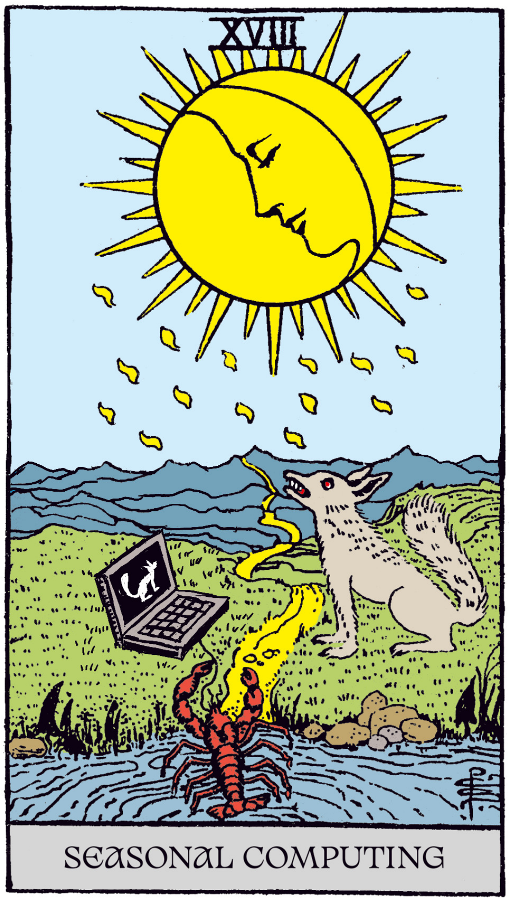
Raised fists show a protest in solidarity. A tower, symbolising coercive power and oppression, is struck by lightning and the people in charge are falling.

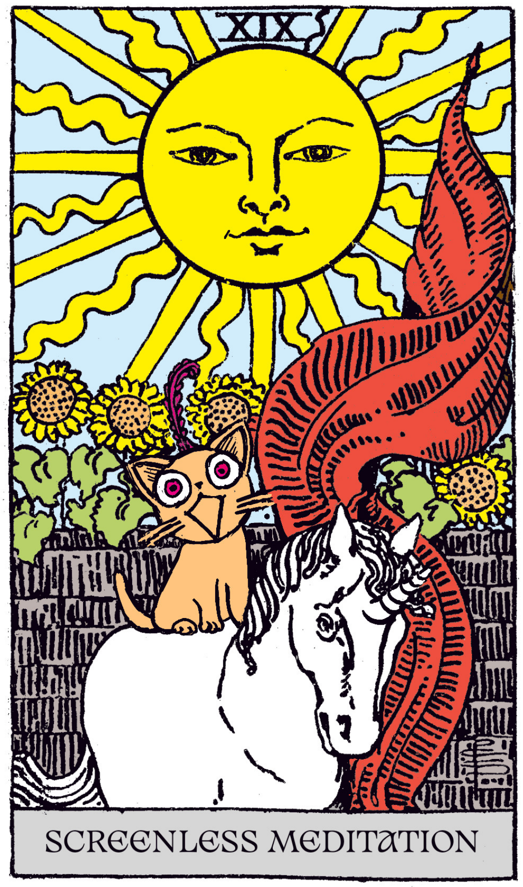
Collectively and in solidarity; protest, organise and talk to policy makers about setting limits to Big Tech's water, land, labour and energy abuse, locally and globally.

XVII. Limited Availability

A person kneels by a pool of water in starlight, nourishing themselves and the earth with water.

Constrain access to people and resources to avoid overwhelming people and planet. For instance stick to office hours when serving online content or meditate on how a new idea can nourish rather than deplete energy.





XVIII. Seasonal Computing

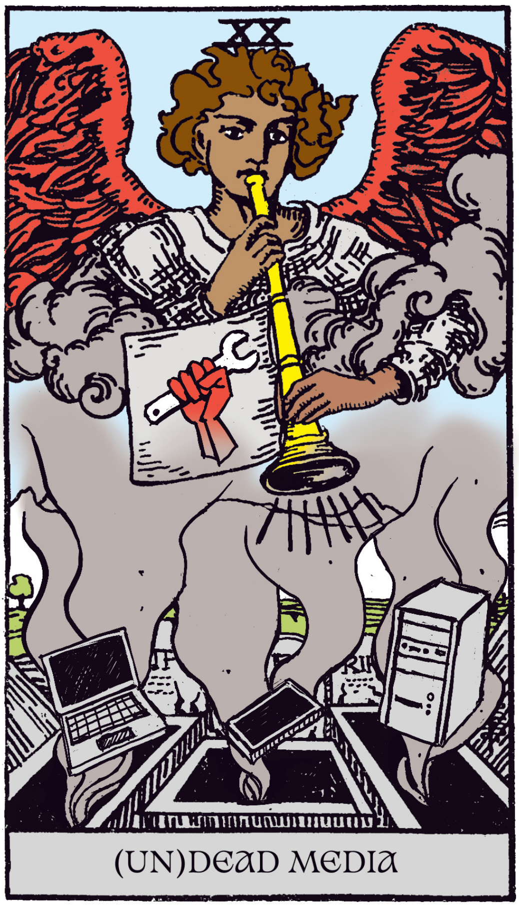
A wolf howls at the moon while they are in a video call with a friend. A crayfish shows the wolf a moonlit path to freedom from always having to be available.

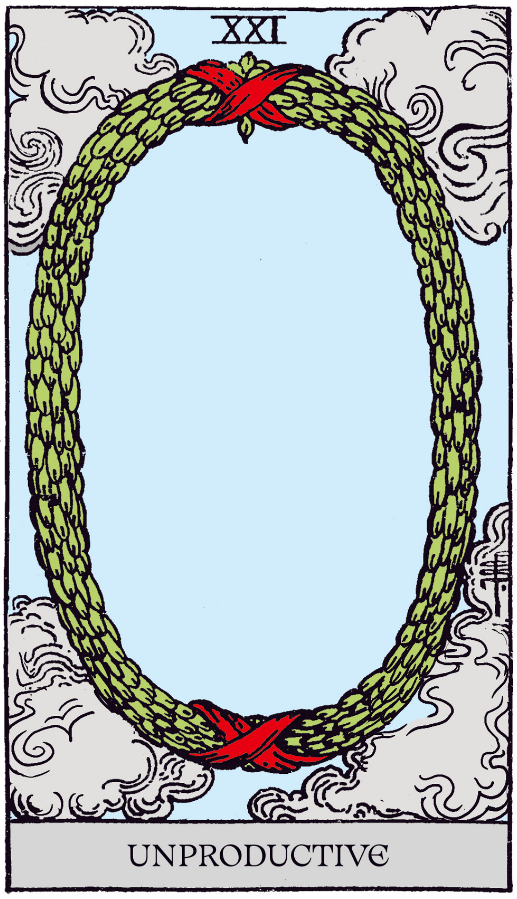
A way of computing that is tied to certain moments in the year, cyclical and not always available, only in spring or for the full moon. Based on a conversation with Alice Strete and Cristina Cochior during the project ATNOFS.

XIX. Screenless Meditation

An ecstatic cat sits on the back of a unicorn in a sunlit garden.

Turn off your computer. Put your phone in a drawer. Go outside.





XX. (Un)dead Media

An angel blowing a trumpet with a ‘right to repair’ flag. A PC, a laptop and a phone rise from their graves.

Bring the dead (dormant) media back to life. Build new from the old, revisit the past…

XXI. Unproductive

A laurel wreath in the clouds encircles… nothing.

Maybe doing nothing is a way. Not adding or extracting for once.

Colophon

Card design and text by Marloes de Valk. Coloring, design of the manual and production by Alex Leray. Box design by Muriel Gerhart. Riso Printing by Ronan Deriez. Typeface: Basteleur by Keussel Studio (SIL Open Font License).

This publication is licensed CC4r (Collective Conditions for re-use) not only because of the long and winding history of the original Smith-Waite tarot, the redesign was a collective effort too. The cards’ titles and meaning are based on a selection of cards made by the participants of two workshops led by Marloes de Valk:

From Appropriate Technology to Permacomputing: A Glossary of Counter-narratives and Practices, as part of the Tangible Cloud work session, 19-05-2022, in Brussels (BE), with: Agnez Bewer, Élie Bolard, Sofia Boschat Thorez, Simon Browne, Dennis de Bel, Célo, Benjamin Gaulon, Antoine Gelgon, Chloé Horta, Brendan Howell, Alexandre Leray, Nicolas Malevé, Romain Marula, Adrien Payet, Peggy Pierrot, Mariane Plano, Femke Snelting and Thomas Thibault.

chmod 777: writing an executable glossary of (perma)computational practices, at *Art Meets Radical Openness*, 16-06-2022, Linz (AT), with: Alex Zakkas, Dasha Ilina, Louis Frehring, Laura Sophie Meyer, Alice Yuan Zhang, Andreas Zingerle. Cristina Cochior, Christo Buschek, Birgit Bachler, Petites Singularités, Aggeliki Diakrousi, Christoph Haag and Ushi Reiter.

This project was realised with the support of FRArt, in the context of the artistic research *Clearing Up the Mist* (a.k.a Tangible Cloud).

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Appendix

List of publications 2020 – 2024

de Valk, M. and Sire, N. (2020) 'Interview with Nestor Siré [Part I]', *The Photographers' Gallery: Unthinking Photography*. Available at: https://unthinking.photography/articles/interview-with-nestor-sire.

de Valk, M. and Sire, N. (2020) 'Interview with Nestor Siré [Part II]', *The Photographers' Gallery: Unthinking Photography*. Available at: https://unthinking.photography/articles/interview-with-nestor-sire-part-ii.

de Valk, M. and Moll, J. (2021) 'Interview with Joana Moll', *The Photographers' Gallery: Unthinking Photography*. Available at: https://unthinking.photography/articles/interview-with-joana-moll.

de Valk, M. (2021) 'A pluriverse of local worlds: A review of Computing within Limits related terminology and practices', in *Seventh Workshop on Computing within Limits 2021*, LIMITS. Available at: https://doi.org/10.21428/bf6fb269.1e37d8be.

de Valk, M. (2021) 'Refusing the burden of computation: Edge computing and sustainable ICT', *A Peer-Reviewed Journal About*, 10(1), pp. 14–29. Available at: https://doi.org/10.7146/aprja.v10i1.128184.

de Valk, M. (2022) 'rosa's ecofeminist dictionary', in *A Traversal Network of Feminist Servers*. Rotterdam: Varia, pp. 167–176. Available at: https://varia.zone/ATNOFS.

de Valk, M. and Heikkilä, V.-M. (2022) 'Permacomputing', *Counter-N*. Edited by S. Miyazaki. Available at: https://doi.org/10.18452/25609.

de Valk, M. (2022) ‘Damaged Earth Catalog’, *Damaged Earth Catalog*. Available at: https://damaged.bleu255.com.

Schuler, D. et al. (2022) ‘A pattern language for the LIMITS community: We make the road by walking, A messy ethnography’, in *Computing within Limits. Eighth Workshop on Computing within Limits 2022*, LIMITS. Available at: https://doi.org/10.21428/bf6fb269.53f254b3.

de Valk, M. (2022) ‘A paper archive: Documenting the live performance Capitalist Magic’, in *Nordic Human-Computer Interaction Conference*. New York, NY, USA: Association for Computing Machinery (NordiCHI ’22), pp. 1–6. Available at: https://doi.org/10.1145/3546155.3547293.

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de Valk, M. (2023) ‘rosa’s ecofeminist dictionary’, *Sun Thinking*. Available at: https://solarprotocol.net/sunthinking/devalk.html.

de Valk, M. (2024) ‘The damaged Earth catalog: Technology on a depleted planet’, in A. Jehle and J. Schickedanz (eds) *Aram Bartholl: Package Ready for Pickup*. Osnabrück: Distanz Verlag, pp. 63–65.

List of presentations 2020 – 2024

14 June 2021, presentation of ‘A pluriverse of local worlds: a review of Computing within Limits related terminology and practices’, at *LIMITS’21: Workshop on Computing within Limits*, online.

30 November 2021, presentation of ‘Refusing the burden of computation: Edge computing and sustainable ICT’, at *On the Edge #1*, with Laura Marks and Olia Lialina, Merz

Academy, Stuttgart. https://www.merz-akademie.de/en/veranstaltungen/on-the-edge-1

10 March 2022, presentation ‘From Appropriate Technology to permacomputing: A glossary of counternarratives and practices’ at *FIBER Reassemble Lab: Natural intelligence, towards renewable and regenerative digital infrastructures*, Amsterdam.

28 April 2022, performance ‘Capitalist Magic’ and talk at *NØ LAB: Post-despair*, la Gaîté Lyrique, Paris.

18 – 21 May 2022, workshop ‘A Glossary - mapping the territory’ and ‘Executable words - a deck of (magic) pattern cards’ at *Tangible Cloud*, Green Fabric, Brussels, 18-21 May 2022.

15 June 2022, keynote ‘RWXRWXRWX: Pattern languages and keywords to debug computational practices’ at *Art Meets Radical Openness*, Linz.

16 June 2022, workshop ‘chmod 777: writing an executable glossary of (perma)computational practices’, at *Art Meets Radical Openness*, Linz.

22 June 2022, presentation of ‘A pattern language for the LIMITS community: We make the road by walking, a messy ethnography’ with Douglas Schuler and Shreya Urvashi at *LIMITS’22: Workshop on Computing within Limits*, online.

12 October 2022, lecture-performance ‘A paper archive: Documenting the live performance Capitalist Magic’, at *Nordic Human-Computer Interaction Conference*, Algorithmic Speculation track, online & Aarhus University, Aarhus.

18 January 2023, presentation ‘Damaged Earth Catalog: Technological strategies and critique for a depleted world’, at research workshop *Toward a minor tech*, LSBU, London.

03 - 05 March 2023, exhibition of ‘Tangible Cloud Oracle’ at *Tangible Cloud*, Gallery KBK, Brussels.

22 June 2023, presentation ‘Permacomputing’, at the symposium *Material Ecologies of Media and Their Histories*, by Olga Goriunova, David Young, JP Kelly, Nick Hall and Hugh Hammond, Royal Holloway University of London, London.

23 September 2023, lecture-performance ‘A tale of two data centres’ during *The Hmm’s Data Centre Tour*, Amsterdam and Middenmeer.

02 December 2023, lecture-performance ‘A tale of two data centres’ at FIBER’s reassemble lab *Practising Permacomputing*, Tolhuistuin, Amsterdam.

22 January 2024, lecture-performance ‘A tale of two data centres’, *Special Issue 23: Quilting infrastructures* by Alice Strete and Cristina Cochior, at the Master Experimental Publishing at the Piet Zwart Institute, Rotterdam.

26 February 2024, presentation ‘Permacomputing’, *La Nuit des Idees 2024: Faut-il craindre les machines?*, Institut français NL, Openbare Bibliotheek Oosterdok, Amsterdam.

27 May – 1 June 2024, exhibition ‘Tangible Cloud Oracle’ at *Media Mediterranea*, Metamedij, at Galerija Novo, Pula.

28 June 2024, lecture-performance ‘A tale of two data centres’ during *Synthetic Vision/Images of Power* symposium, Leiden University, at Framer Framed, Amsterdam.

09 November 2024, lecture-performance ‘A tale of two data centres’ during *The Hmm’s Data Centre Tour*, Amsterdam and Middenmeer.

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